1874. Telegraph - Notes and Essays (NS-74-002)

This folder contains notes and drafts for a proposed book or series of essays by Edison on telegraphy and related electrical subjects. Similar material can be found in NS-74-001 and NS-Undated-005, Unbound Notes and Drawings; in Laboratory Scrapbook, Cat. 297; in Laboratory Notebook, Cat. 30,099; and in Laboratory Notebook, Cat. 1176. The essays on duplex telegraphy (items 4-6, below) appear to have been prepared for The Operator, Vol. 2, nos. 1, 3, 6 (1874). The essay "On the Effect of Self Induction . . ." (item 19, below) was prepared for The Telegraphic Journal, according to a docket on the back of one of the pages. The following is a list of the documents in this folder:

1) "The author of this work . . ." (1 page; incomplete).

2a) "Notes & Ideas for Book." (3 pages; Edison's hand).

2b) Transcription of (2a). (1 page).

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

3c) Transcription of (3b) plus some additional material. (18 pages).

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

6b) Pages 1-7 of (6a) in Edison's hand. (11 pages).

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

7b) Transcription of (7a). (4 pages).

8a) "Morse Telegraph contends with Line," page 2. Transcription. (1 page; incomplete).

8b) This appears to be a continuation of (8a) in Edison's hand. (1 page).

8c) Transcription of (8b). (1 page).

9) "Chemical paper . . ." Transcription. (3 pages).

10) "In the American System . . ." Transcription. (2 pages).

11) "Printing Telegraphs." (9 pages; Edison's hand).

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

12b) "Break Wheels." Another version in Edison's hand. (5 pages with Batchelor's annotations).

12c) Pages 16 (2 versions), 17, and 18 of (12a) or (12b). (4 pages; Edison's hand).

12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

12e) Illustrations for essays on breakwheels. (9 pages; Batchelor's hand; one may be by Edison).

13) "Electromagnets." (4 pages; Edison's hand).

14) "The laws which govern . . ." (2 pages; Edison's hand).

15) Incomplete essay, pages 9, 12, 14, and a damaged page. (4 pages; Edison's hand).

16) Incomplete essay, pages 21-23. May be a continuation of (15). (3 pages; Edison's hand).

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

18) "If a current be sent . . ." (1 page; Edison's hand).

19) "On the Effect of Self Induction . . ." (4 pages; Edison's hand).

20) Three pages of fragments from essays in Edison's hand.

Preface

Chap 1. Elementary Movements.
2. Miscellaneous Movements
3 Contact points & Break wheels.
4 Batteries.
5 Induction of E magnets & testing
6 Electromagnets
7 Secondary Voltaic Action
8 Translators & Repeaters
9 Static charge of Tel lines
10 Duplex
11 Chemical Telegraphy.
12 Automatic Chem Tels Bain & Dash & Bma
13 Printing Telegraphs
14 Miscellaneous Tels
15 Electrical Measurement
16 Miscellaneous Tel. Instr.
Appendix
Notes.
Index

Unbound Notes and Drawings, 1874-1878

1874. Telegraph - Notes and Essays (NS-74-002)

[This page should precede the document on reel 7, frame 44]

1

The author of this work does not propose to merely reproduce on its pages that which has already been published upon this subject nor to describe elementary (ions) electricity. Nor is it the purpose to put before the public a collection of elaborate and difficult problems in electricity. But the object is to simplify that which appears to be so little understood upon this subject. The author proposes to do this by presenting to the public in this work a series of experiments as performed by him. Having been for a number of years actually engaged in experimenting in telegraphy and electricity in general. The author also will explain numerous observed phenomena in electricity they having been noticed by him and which is not generally known

1) "The author of this work . . ." (1 page; incomplete).

Notes (1874)
& Ideas for Book -

Where very delicate currents are used to move the armature lever of a relay the magnetic Effect of the passage of the Local Current through the local points will stick them together by using a high R Bobbin of ~~Chem~~ battery of two cups. ~~a single 1 cup~~ for the local circuit. Signal at 30 words per minute were ~~recorded or~~ read on ~~relay~~ a very delicate relay worked by 2 cells through a high Resistance - When two grove cells were substituted for the two Daniel in the local circuit the

2a) "Notes & Ideas for Book." (3 pages; Edison's hand).

2

No ~~signals~~ intelligable signals
Could be received the magnetic
Effect of the powerful Current
passing through the Contact
points was greater than the
~~retractile force of the spring~~
~~[illegible]~~ Effect of the
Current passing through the
relay.

add 11 mo 72

The British Pool of Dept
refused permission to use
a grove battery on the air
Lines

2a) "Notes & Ideas for Book." (3 pages; Edison's hand).

3

Try Resistance with Mirror
Galvanometer of a Glass
Tube filled with finely
powdered peroxide of
Iron also with powdered
peroxide of iron.

not Enough force to the coils
to overcome the angle of
X & was left

2a) "Notes & Ideas for Book." (3 pages; Edison's hand).

No 1

Notes
and Ideas for Book

Where very delicate current are used to move the armature lever of a relay the magnetic effect of the passage of the local current through the local points will stick them together by using a high R Danel battery of two cups for the local circuit signal at 30 words per minute were read on a very delicate relay worked by 2 cells through a high Resistance – when two grove cells we substituted for the two Danels in the local circuit no intelligable signals could be received the magnetic effect of the powerful current passing through the contact points was greater than the effect of the current passing through the relay – add Morse

The British post office Department refused permission to use a grove battery on their lines

Try Resistance with Mirror galvanometer of a glass tube filled with finely powdered sesquioxide of iron also with powdered per-oxide of iron

Not enough force to the water to over-come the angle of X wash it

2b) Transcription of (2a). (1 page).

No 1. Notes [COPY - ORIGINAL BY T.A.E.]

neutralizing Escape Show Kromer Method in a new form
Show Smiths arrangement in good form Show 3 modification
of my, Wh arrangement
Say Bradley gold plate rubbed with cloth will Electrify the
needle and cause it to stick to metal circle May be
discharged by lay the flat of the hand on it - Show good cut
also separate cut showing coils and needle
Polarized Relays the Iron being polarized by a small constant
battery M. C - etc - clockwork battery charger for —
cut and discription Watkins - burglar Alarm - 1 dozen
good escapements, 2 or 3 good unisons self Starting
register Register Repeater by lever and embossed paper
Duplex - having sending receiving his own writing back
My two ways duplex cut and discription with way stations
discription and cut My battery also results of experiments
on preventing of diffusion if that is not so then the reason blue
Kept down cause the action takes place right at cathode and
blue vitriol used as fast as it tend to rise where in old
Magnets no action takes place on rising fluid but way
down at bottom Test that spring pulling with and pulling
against explain why That induction be greater on Lines
where poles dont make good earth for in that case the
distance from one wire to the other goes over the same
material that it goes to the ground hence if the pole

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 2

be very dry and makes poor earth on closing conduction takes place across the arms but quickly cease owing to the polarization of the contact part of the wire by the moisture of the wood this would explain the great induction on the overland wire running through dry dust one of the reasons why receiving on a ground wire is not uniformly successful is because of return currents from other wires which which where exactly equal works the relay open when distant man closes and when not equal reduces the effective working strength of the distant current secondly to the variations of the return leakage owing to the weakness of the feeding batteries this cause of bad working in Duplex balances the leakage is done by the plan now used but not on Duplex I was told at Greenwich that earth current on A cable sometimes potential so 10 and cells changes from N to P sometimes in less than ½ minute

Spark due to a great number of magnets in circuit may be apparently ameliorated by putting square foot of tin foil each side etc placing thick pieces of paper between armatures and screwing magnet up close so as to get core near armature and use powerful spring of paper get very feeble signals

pointed platina points make better

No 3

contact and longer than flat ⊐⊏ because in this case that oxide has a clearance but with flat points it has not –

Compressed platina hydrolic or very hard drawn gives less spark but for inst. convenient I dea that sounder points close circuit better than relay etc gold leaf tips etc – show loss of part of signal by changing line

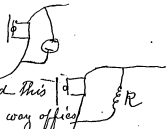
Why spring points should be used about rebound of all keys – proved by the quick fall of currents generating and breaks in induction of magnet in bridge showing ——— when held in full power with spring light ——— bad connection in revolving shaft – vibrating points best

Compressed air sounder v.s. secondary battery induction of condensers cells Lyden jars secondary chemical action A+Cable

Say chemical recorder splended instrument for investigation by comparison

Secondary battery shunting a relay

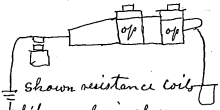
Discrete effects show cross currents



Automatic Plan of putting number way office on wire and get signals from main Relay –

No 4

Work up System of Regeston repeating so as to Combine
number of branch offices with main office message received
Embossed and transmitted one main wire from Embossed Strings —
Say peculiar strong paper used and peculiar high inbossing
— Say old G. and S. Relays although only $\frac{1}{8}$ T lang retarded
Speed waves Anthony Short Slotted relay [illegible] allows
of nearly double no waves be used 1000 used by Gold
and Stock Effect polarized yet not.



See if in movement prevention
of acting by Vibrating P and
reverse coils double in Electromagnet shown resistance coils
of Kansas Stone and plumbago graphite also in glass
hard rubber etc = mention where a wire may get
grounded through local connections with battery an
floor damps place office were for local running in damp
walls over gas pipes etc = Some magnets used at
Louisville having a total length 11 inches worked bad on
dry day say nothing of wet day secondary battery action
on land wires How working with a heavy battery
through a weaker opposing battery gives weak currents in
closing — P. and A. test Dec 27
Compensating Defects of reverse currents where strong
enough to fully clear the wire and give an effect —

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 5

My Relay worked by Duplexing the polarized and working from the discharge of the magnet –
Why a polarized tongue should lay horizontal instead of perpendicular

Woods Buton
Authon Buton
Hicks old
Hicks No 2
Hicks latest
Bunnell
Haskin
M Ulkins

3000 words per minut

dots & dash marks can be burned in potential at the rate of — per minut by using a platina wire and keeping hot by battery (Horn) Register may be used for perforating paper next to platina for cones Nickel – in most instances it is as good as platina and very much cheaper
It is used for contact roller in perforated paper transmission and gives good contact at

This discharge from the magnet in a wheatstone receiving instrument interferes with the Spired shown chemical records – The reason why the Spark is so much greater on a local current with a grove or carbon battery change with a Callaud of the Same strength is owing to the greater internal resistance of the – by short circuit a more telegraph battery composed of grove or carbon battery we obtained a dazzling electric light but if 20 ohms or even less be inserted as a part of the short circuit wire the Spark is only just perceptable – This extra resistance

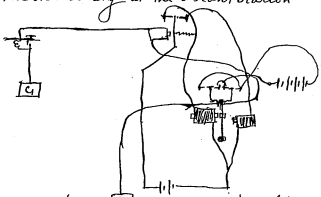
3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No. 6

is inherent in the Wagner line for local circuits in different apparatus when a great number of contacts are made the Called should to used movements.

Paper had it

Method of getting reversed on a line at one station when form one battery at the distant station

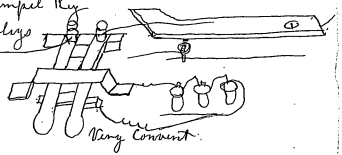


Paper - P 19 - to make ordinary Redflued - 1 gallon Sala 8 gal water in Separate Vessels dissolve 5 lbs Borchas in 2 gal boiling and add to the Strength through the proportions of potash Sometimes made greater to make a more granulizing flux add one gallon water Saturated to one gallon Sul a

Simpel Key

Reversing Key

Varlys



Very Convent.

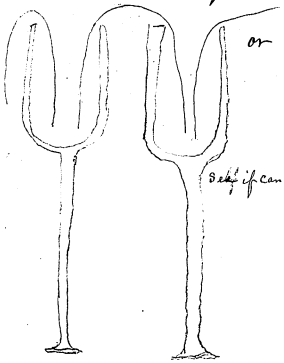
3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 7

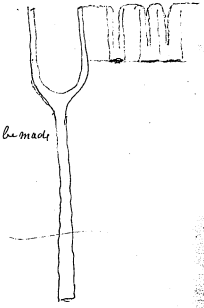
Very weak receiving currents sometimes the permanent magnetism is equal to received currents in that case the relay opens when Key closed & Reversed current translator left fine open ckt separates several RR signals get disruption from spring

Dest battery

when better insolator required this



or



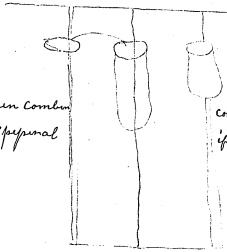
Sely if can be made

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

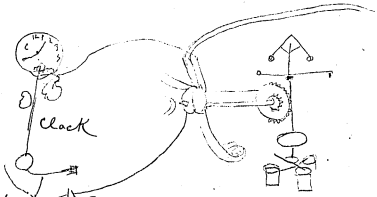
No 8

Simple Galvanometer

get good cut of Amen combin instrument. Phelps good Sprpural



connected see if Rods work



Lenants Self adjusting Relay Siemens polarized relay
Thomsons Munson good reversing Key Self closing Keys
Van Hoovenbergs unison Van Hovenbergs rattler Sounder
Switch boards all Kinds Magnetime when testing long magnets
dont shake floor to increase Electric battery get bad results
dont test magnets within several feet needle

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

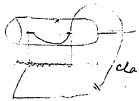
No 4

mention proposed by little weeks signals so as to not show static – say how works but this already done by ——— will bring little results – Some persons adds condenser but this decreases instead of augmenting it – Experiments made between W. & N.Y. gave highest but 90 w per minut on mast sensitive iron paper that was readable good rain produces his results in long currents how a half current should be sent for dashes

How first part of letters should be longest 0000

How speed increased by using European Alphabet and close spacing

Show results on paper where it is attempted to work 10 until ——— Duplex showing automatic perforated paper Duplex My perforator all new – modification by Jackscell Man Roman perforator old paper feed. 3 Key perforator. Combination to produce Morse characters etc roman Embossing 45 lever printer chemical printing machine Milwaukee copying machine

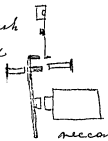


Thick ink from filings

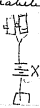
3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 10

artificial Cable — artificial cable with magnets
artificial " with Secondary batterys gives
Experiments and recorded results with all — Bradleys
Spools — test of strength compared with S.A.C Same R.
Duplex Steam may have way stations receive by
using a very short relay shunted = and the currents from
the stations sending is double strength of the other
current — Duplex — be best when relays
arrange cut for that a Relay is best with
Spring points this
Gutta percha throte Varnish
to coat arms of grove and
other zincs in place of
asphaltum which



Sprangy try it asphaltum recommend by paper
oil on Collard battery nuisance — wooden cos prevents
Evaporation Effectualy — to make carbon battery last
long which provis part ½ inch thick — try.
where there are several magnets in them some current
whose — one vibrated rapedly the stoppage of
any one of these — is liable to alter this
adjustment of the rest



Resistance of leakage being water and subject to
polarization is decreased but pitting on battery

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 11

X hence when every thing is equalized for the taking off of X will take off a electromotive force off of the water leakage

so that when the distant current comes through not so much will pass via water leakage to Earth as through metal leakage but when X it it breaks down the resistance of the water drops denotations X although equalized move of the distant current will pass through leakage owing to the peculiar effect of X in reducing R of water

the advantage of A — permanent current is that the leakage on cross fine generally all in on denotation when as other English lines we receive currents in both direction so that we a current between Nil and 30 Elements and on the English lines between between 30 positive and 30 negative on a disturbing effect of 60 Elements

—

will always be a drawback to fast systems

Excessive underground work as well as the close proximity of one wire to another and the use of cotton wires to prevent cross currents all of which are in use in England render them system far inferior to the american — say about static charge increased

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

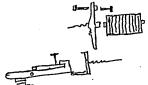
No 13

follows that the current will divide Equally upon the regular and artificial line and move 1 Yoass down the receiving instrument as the resistance on both sidis are equal and there is no cause for a difference of L — if no Condenser was connected to the artificial line that portion of the current due to the static charge of the line would Yass through the instrument This resistance of the artificial line can be reduced to less than the resistence of the line and the difference compensated for by increasing the resistence of the Rheostat B. but the decrease of resistance between the one armature of the Condenser and the other of course decreases the Electrostatic capacity of the artificial line, d; when Signals are received the distance station more than one half of the current passe through the coil A, to the ground via H the other portion through the relay thence through B B the ground and a Small Yortion through d to the ground when the Signal causes the induced current from the magnet circulate within the circuit formed by A. B. C. Thus preventing the instantaneous charge and discharge of the relay and mutilating the signals in the exact proportion as the length of the cores of the magnet and number of the Convolutions are increased and the resistance of the derived circuit. This Effect is partially compensated for by the slight changes

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 14

which are generated by the small quantity of which passes to the ground through D, Mr Stearns is the inventor of another very ingenious modification which is shown in figure —

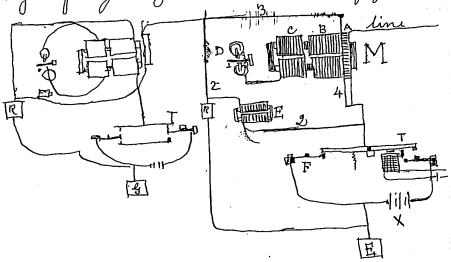


the effect of the outgoing current in this method is compensated for by mechanical means a, is a lever B, a retractor spring having a tension equal to the extra magnetism on the relay due to the outgoing battery this lever comes in contact and rests on the extension of the relay lever when the sounder lever raised and at the instant the contact points seperate and the battery BC is thrown on the line the advantages of this method is that if the equation be not perfect no extra signals will be thrown in as in the double coil duplex but the effect will be to require the spring X to be adjusted frequently Mr Stearns discreches no method of counter-acting the static change This change may be counter-acted mechanically as shown in fig

the following methods were devised by the Author and are on illustrations of the enormous number of combinations which it is possible to make with telegraphic apparatus a portion of them have

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

Serious defects while others are while others will perhaps be
found as more perfec than the methods now use the method
which I shall now dis-crib is worked inbely by induction
which requires less perfection of balance and has a greater
working margin besides allowing the use of apperatus which
is nearly self adjusting this method shown in figure



M is a long Electromagnet upon which are wound
the coils A, B, in opposite directions on to another the coil A
is in the main line circuit and the coil B in the artificial
line R, is the resistance coil adjusted so that its resistance
including the coil B, Equal to the resistance of the line C
is an extra coil not in connection with either circuit the

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 16

line free ends of the coil is connected to a polarized relay O
E is a long Electro magnet with the armatur in permenent contact with armatur cores, and is connected so that that por portion of the current from the batery X which passes into the artificeal line, divides half passing through the Coil B and the other half through the magnet E, when the Saunders lever is actuated by closing the Key R battery X is thrown on the line were the magnet E, disconnected and there were no static charge on the regular line the two coils A B would balance Each other and produce no induction current in coils C, but if there was a static charge on the line the balance would be distroyed the cores of M would become magnetic in proportion to the strength of the static charge this would induce a current into the Coil C actuate the polarized relay relay but if the magnet E, is connected the current which passes through it sets upon inductor charge which circulating within the circuit formed by the wires 2, 3, 4, produce an Electromotive force in the Coils B, Equal to that produced by the static charge in the coils A the coils A, B, being balanced ~~in~~ are what themselves producers of induced currents when the line is very short the magnet E should be short as in that case the regular line sends short charges while

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No. 17

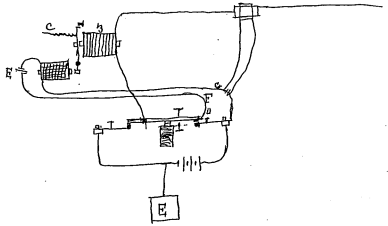
the magnet does the same thus all Effects of the outgoing battery are balanced and the induced currents generated in the coils C, actuating the polarized relay are due to the excess of current from the distant circulating in the Coil A, when the strength of the distant current does not fall below a certain point the polarized relay D, is self adjusting = receiving - being worked by the inductid induced currents above and independent of their strength except they fall below a certain point

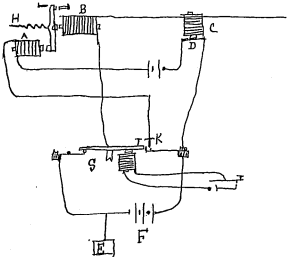
the magnet E, is infinitely more powerful than a Condenser in proportion to size and cost and convenience the author believes himself to be the first person to discover the merits of an ordinary Electromagnet for compensating pour-passes in telegraphing the numerous successful applications which he has made of it a clearer description of the induction Effect of the magnet F may be found in the chapter relating to magnets

The next method is shown in fig and consists in Equating part by the joint action of an Electromagnet and retractile Spring

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No. 18





3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 19

The Sounder lever connects and disconnect the battery, F, in the usual manner on additional point, K, is added to that which point the local circuit is broken, when the battery F is put to line wether this local circuit one two magnets A, and, D, The Spring H is adjusted so that the lever will respond to the distant signals when the Battery, F, is to line and passing through it were the battery, F. Taking off the tension of the Spring would have to be decreased in the Exact proportion as the strength of the magnet, B, was decreased by disconnecting the battery, F, to get the distant signals but at the moment that the battery, F, is disconnected the local circuit is closed and the strength of the magnet A is produces as force acting in the opposite direction to the Spring upon the lever the magnetism in this magnet is Equal to the magnetism which had been power in the magnet, B, due to the battery F hence by the joint action of the Spring and local magnet the lever is always adjusted for the distant signals The magnet, D, also in the local circuit; acts as the primary coil to the Coil, C, which is in the main line, at the moment of putting on the battery, F, the local circuit is broken at the point K, The Core of D, discharges and an induced current is thrown into the coil, C, and on the line Equal to and in the opposite direction to the static charge and when the battery F is

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 20

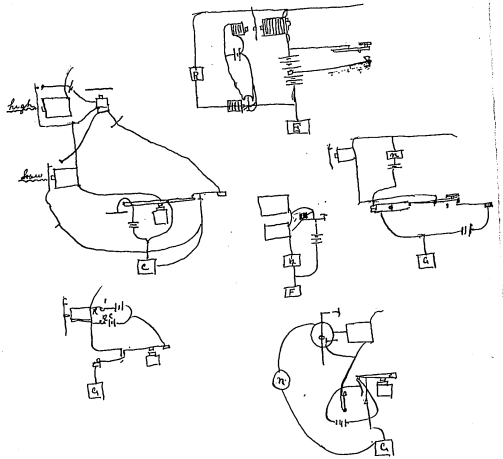
disconnected the local circuit is closed an a contrary charge is induced into the coil, C, and main line equal to the returns static charge in this case the charge is not balanced upon the receiving instrument as in other duplex but neutralized upon the line itself of course this acting upon the whole line neutralizes the charge which runs out at the other end which alows the relay at other end to discharge — and of cours give better signalling in the forms of duplex the charge which runs out at the receiving end tends to shorten the first part of a signal and lengthen the last part but this is prevented by compensating in this manner. the strength of the induction charge thrown into the Coils, C, should be so regulated that it will just neutralize the static charge and give no excess otherwise the distant relay will close a second time and it will also effect the home relay by increasing the coils in the local circuit induction discharges of the most powerful character may be thrown upon the line to compensate for the discharge which occurs on long well insulated circuits=

~~But in a profundy~~

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 21

Put in appendix



3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

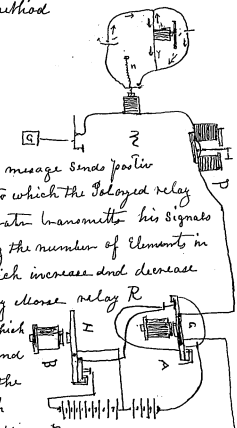
No 22

get copie of those already patented - discribe duplex
arranged on aicable - duplex for Local circuits
duplex a Comon & A-S point line inst
the English reverse current way of using Stearns duplex
The author has taking great pains to test the several
methods of transmitting two messages in the same direction
upon one wire at the same time discribed in Schellen
and others Standard telegraphs works but no one of them
will give readable signals even in the laboratory circuit
it is very questionable whether more theoretical instrument
combination should be inserted in a standard work of
Telegraphy alwaits insurmountable obstacle the problem
to be solved producing a practical combination of this class
of duplex ~~is~~ very difficult to solve
as will be readily acknowledged by those who have
attempted it The value of this form is greater cas than the
ordinary duplex on for instance between N york and
washington where the the great bulk of the business is in one
direction and on press work it has another value which
is that it can be doubled and form messages transmitted
at the same time the author has devised a plan of
sending two messages in same direction which although it
is not him extensively introduced works very sucessfully
he has also had in successful operation in his laboratory

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 28

a quadruplex plan of which is shown in page
in the latter mehament a slight mutilation of the
signals take place owing to self induction but —
will probaly be found found for this end=
fig — gives the single method



one operator transmitts a message sends positive
and Neg at currents to which the Polayed relay
P responds the other operator transmitts his signals
by increasing and decreasing the number of Elements in
the Signalling battery which increase and decrease
shows itself on ordinary morse relay R
the Electro Magnet A which
local circuit opening and
closed by a Key actuals the
reversing lever B, which
puts the P or N pole of battery B
to line as it is attracted or drawn away from the magnet
A — the signals from this instrument recording upon the
polayed relay P — B — is another Electromagnet also in a

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 24

local current opend and closed by a Key. this magnet actuates the lever, H. which increases or decreases the number of Elements of the battery, B. the Signals from this instrument are recorde on the ordinary relay, R, it will be noticed that the local battery whether it be 20 Elements 70 Elements is reversed by the lever 9. the polarized relay, P, will respond to the reversals of 20. Elements on circuits of several hundred miles in length owing to the fact that it has no retracts Spring to over-come and the lightness of moveable parts it will not change its adjustment when the number of Elements are increased to twenty hence the Operation of the lever, H, will not Effect the Signaling due to the reversals= The relay R requirse a greater force to set it in motion the armature is adjusted to such distance from the cores that the twenty Elements has no Effect upon on at least scarcely a perceptable effect when the tension of the Spring, S. is the least which it can be made if the Spring, S, be adjusted properly This relay will close and open Every time the 150. Elements are added on Substractted from the battery, B.

it obvious from the above discription that the Signals due to the reversals will be recorded upon The polarized relay P and those due to the increase & and decrease of the Electromagnetism of the reversers will be recored upon the relay

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 25

R, but it by no means follows that these signals will be perfect – The relay R must be of a peculiar character and a particular arrangement of the local circuit and sounder must be made – to overcome the difficulty experienced at the moment of the reversal of the battery this difficulty which I shall now describe was one of the great difficulties experimenting in the course of experimenting when the lever H of the magnet, B, is depressed permanently the armature of the relay R, is attracted. if now while H is still depressed the battery B is reversed by the lever G, the polarity of the iron cores of the relay R, must change from N. S. to S. N hence there is a instant where there is no attraction power in the magnet the armature lever if the relay were an ordinary one would be pulled away from the face of the cores by the retracting spring for an instant and be immediately reattracted against when the change of polarity had taken place this would open and close the local circuit if arranged in the ordinary way giving a false signal as this takes place at every reversal it follows that the signals would be greatly mutilated – this is obviated by shortening the length of the magnet so that it changing and discharging time shall be several times less than the ordinary magnet and increase the charging and discharging time of the local magnet – when the magnet

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 26

is very short less than one inch. The polarity of the iron cores will change with such rapidity that the armature scarcely leaves the face of magnet even when the spring S. is adjusted so high that signals are rarely recorded and additional protection against false signals is the manner of closing the local current on the back point instead of the front point when arranged in this manner the armature must fly back and rest for an instant on the contact point before it will open the sounder magnet and then will nearly happen except upon very long circuits of considerable capacity the static charge increasing the time of the change of polarity but which comprise them is possible as well be presently shown. Two locals battery are connected to the local sounder the 2 iron poles of one battery is connected to the copper poles of the other battery the sounde is placed in a bredge wire which forms a point of both circuits by tracing the direction of the current when both circuits are closed it will be seen that the bridge were is at zero point this being no difference of potential necessary to cause a flow of current through this wire consequently when the armature of the relay R. is in contact with the back point both circuits are closed and the sounder is open when the armature is attracted one circuit is broken the balance is

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

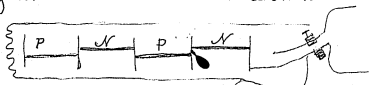
No 27

destroyed and the Sounder closes properly as if there
, There were but one battery and the contact was made
on the front point = The fact that the Sounder is
allowing then a closed circuit allows the self induction
to react upon itself and very slightly prolong its time
of charge and discharge as has been described more fully
in the chapter local circuits the cores of the polarized
magnet P should be very short and the magnets shunted
with high resistance so as to prevent the self induction
current going upon the line interfering with the change of
polarity of the relay R, = were the cores of the polarized
relay of the ordinary length the discharge from them
would weaken the first part of every reversed current and
were it to be shunted to prevent these currents from
interfering with the relay R, the currents circulating
within the shunt would be so powerful that a
mutilation of the signals would take place on the
polarized relay but by decreasing its length the self
discharge can be so reduced that it will no longer
be perceptible = reversed currents sent upon a circuit
upon which end static change takes place is recorded
upon chemical prepared paper thus | P | N | P | N |
the vertical lines shows the points where the relay R, is
liable to open and close

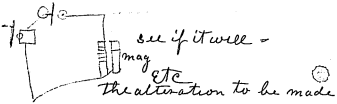
3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 28

long cones the current is recorded thus



or when the relay, R, is short and the polarized relay, P, has long cones some effect is produced, — but when both are very short then the marks do not show any perceptable weakening the same weakeng of the marks shows itself when the record is taken up on a very long line of high induction capacity the first part of positive current being with the induction charge due to the previous negative — when this apparatus is to be used under the latter condition — the Etc Etc



see if it will —

Etc

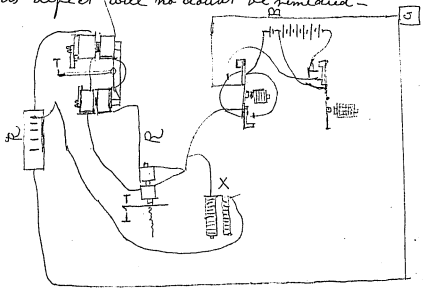
The alteration to be made with this apparatus to make it a quadruplex (see if if proper) is to combine two sets together with double coils on each magnet for balancing the out going currents upon the receiving instruments figure shows the connection at one station only arrangement at the other station being precisely similar I have separated the coils in the magnet so as to simplify the connection

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No-29

the relay, R, and P, being provided with equating coils placed in the artifical line formed by the rheostat, R - and magnet, X. (the latter for compensating all effects of the manipulation of the battery B can be neutralized on, R, and, P, show former duplex key and instrument in right place =

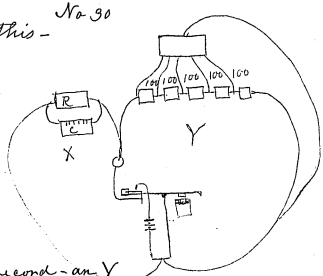
This induction action of the currents from the distant station thrown with the artifical circuit by the double coils renders the signals at certain periods of time when the four keys are being operated rather shaky but in line This defect will no doubt be remedied -



3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 30

Try this -



But if X dont record - an Y

mention that Garret Smith one of the chief Opts of the W U Telegraph office in New York Succeeded in applying the Stearn duplex to A Combination printing which worked very Successfully between New York and Philadelphia - Chemical paper

In the investigation of the static charge upon telegraphic circuits the chemical recorder is of great value in fact many of the phenomena attending these discharges can only be investigated with this instrument it gives reliable records of changes which takes place with great rapidity it is also of great value in determining the induction of magnets and is as yet the only means by which a near approach of the capacity of a circuit can be obtained great difficulty was first Experienced in obtaining a chemical solution

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 31

which should have great delicacy and still give marks of a permanent character paper prepared in a saturated solution of iodide of potassium in which solution there is a small quantity of flour and Nitrat Soda — is extremely sensitive (see above) to the electric current giving a perceptible mark with one cup of battery through a Resistance of 00000 ohms but the marks are not permanent great drawback in experimental investigation — ferrocyanide of potassium with Nitrate of Ammonia as given in Culley and others combination of ferrocyanide of Pot with other substances described in telegraph works are infinitely less delicat than the Iodide of potassium there been about the proportion of 40, to, 1 — besides a polarization of the pen takes place with the other solution which tends to give capricious results..

The author formula as now used by the American telegraph Constructs and m co gives paper of the greatest delicacy who made in the proper manner the marks are of a permanent character and bear points of delicacy to iodide formula as 38 to 40 Tourmule water double Chl of Gold and Sodium from on Tin pen Etc Etc direction the Chloride of Sodium is a very Expensive Salt but as little is used the rolls of paper costs but little more than the ferrocyanide paper and several Times less

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 32

than the Iodide of potassium paper – the wet paper will have a light yellow color and the mark will be not of a rich purple and very permanent no polarization of the pen takes place with this Solution –

an other formula possessing nearly the same delicacy and much less expension and which gives marks if a permanent Color is 1½ ounce of the ferrocyanide of potassium
one gallon distilled water 1 lb of chloride of Sodium
stirred untill dissolved not

the ferricyanide of potassium is a salt which it is one dificult to obtain at the drug warehouses may be made from the ferrocyanide Etc
This salt is not decomposed by light and paper saturated with it will retain its virtue keep moist for any length of time if placed in a closed jars prevent evaporation after it can be used immediately after immersion in the solution but clear marks will be obtained after the excess of fluid has been evaporated and the paper is just moist to the touch = formula No 3 water Logwood Chl S – Etc
This Solution has a delicacy as great if not greater than the iodide of potassium paper and gives permanent marks but has the drawback that after a short expasure that Logwood is decomposed and the paper nearly the same shade of color as the original marks formula 4
1 – water chl – a solution of cochenile freed from fat by digesting with Ether
this formula is very delicate gives marks of a permanent

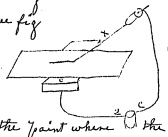
3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No. 33

Character but the marks do not show plainly as other formula owing to the deep color imparted to the strip by the coloring matter of the cochineal= formulas, 5 pyrogallic acid formula – 6 Sulphuret of pot discribe formula 7 – hydrosulphuric acid discribe „8„ hydrosulphat ammonia – discribe – these formulas are the results of an immense amount of experimentation The author laboring under the load of a very small knowledge of chemistry – at the outset

The principle of chemical recording is this if a current be passed through an iron wire on paint resting upon paper moistened with water

See fig



which formed of two atoms of hydrogen and one of oxygen the water is decomposed the hydrogen on the plate C and the oxygen at the point where the wire X, comes in contact with the paper – this oxygen being in what is called nascent state oxydize the iron forming the first oxide or protoxide of iron

this oxide is white and will be imperceptable, if the paper is exposed to the air for a very short period of time the first oxide or protoxide absorbs more oxygen from the air when its nature is changed and a new and entirely distinct compound is formed, called the sesquioxide or peroxide according to the length of time the paper is exposed to the air the protoxide is always formed at the first instant the current is passed through the paper

Note bodies which have just been set free from one combination have more powerful affinities than when already free

No 34

providing the metal used in oxydizable - if now insted of using water the ferrocyanide of potassium forms a part of the solution - which is reccomended in nearly all Standard works on teleghing the pro protoxide would not combine with the ferracyande of potassium to form prussian blue untill the protoxide has been changed into a higher oxide (18) iron with in combination with iron there 1 atom of oxygen) as this takes a small period of time it follow that if the wave follows Each other very rapedly that there will be no time for the higer oxidyzaton to take place hence at the propititous moment when the oxide is in a state to most powerfully Enter into another combination it finds no Substance with which it can combine until it has been free for some time then it enters into combination to forme prussian blue but very slowly and the results are inferior another Effect takes place which is that the protoxide is formed upon the surface of the iron relay and where it finds no salt to form a combination so as to free it forms the pen by slight pressure the particles of the oxide cling with intesty to the iron & are spread over the surface of the paper to a greater Extent than if it could comebine at the instant it was formed two Springs of paper one moistend with iodide of potasum the other with ferracyand pot and what A placed side by side recorded at a given Speed thus Iodide - - - - - - - - - - - - - - - - - -

Ferro - - - - - - - - - - - - - - - - - -

it will then be seen that The ferrocyande of patassium does not combined with the first oxidis formed by Electrodecomposition hence it has little or no delicacy and is worse then useless either in Expermentation

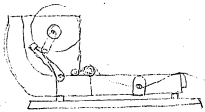
No 85

or telegraphing it is obvious from the above that some chemical which will enter with avidity in combination with potassic of the metal which combination has a conspicuous colouring ~~the~~ Auric Chloride of Sodium is logwood ferrocyanide of potassic cochineal Purpurin Etc are such salts in the case of auric chloride of sodium the gold combine with etc to form the purple of cassius with ferrocyanide of potassium it combines with the protoxide formed by decomposition of the water to form Turnbulls blue sulphur of it the hyposulphite combines with the protoxide of iron form the sulphuret of iron all of which are insoluble in water and cold dilute acids were they soluble the marks would not be permanent - the peculiar action of the water principle of logwood and cochineal with the protoxide is not so clear The Author has noticed several compound solution of his experiments the base of which were organic matter which was more sensitive to the Electric current when when there the most delicate mirror galvanometer but the marks were the most fugitive character further experiments will probably given a permanency to one or more of these solutions the value of which in automatic Telegraph cannot be overestimated - for all solutions where the stylus takes part in the chemical - combination considerable pressure of the stylus must be given on the paper so as to deposit the new compounds upon the paper and prevent mechanical dragging

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 36

out of the signal thereby producing attenuation of the marks independent of the same attenuation produced by the static discharge when the styles does not enter into combination for instance a platina and iodide of potassium light pressure can be used without mechanical attenuation chloride of sodium or common salt is added to all these solutions to reduce the resistance of the moist paper so as to augument the amount of decomposition the paper which is to be used is not a matter of indifferance fine thick well washed bulbus cotton paper will give infinitely sharper and more perfect signals than ordinary paper figure — shows a very convenient instrument for wetting the paper



it is recovering etc etc

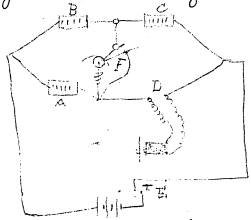
fig shaw reel

Roughend milled heads prevents slack etc hard rubber — the self induction of electro magnets — the self induction of electro magnets is one of the greatest drawbacks to perfect

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 37.

instrumentation in system in which they are employed the instruments what I used in the following Experiment was the chemical recorder with two recording stylus resting on the paper which moved uniformly by clockwork controlled by a very accurate governor arranged in the bridge wire of a — bridge in one of the branch of which is placed the magnet to be tested figure show the arrangement=



any device which is susperiedd of generating induced currents or secondary currents due to chemical action may be inserted in the branch D.

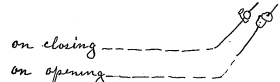
The Branch A and B being Equal and the resistance of C, being made Equal to the resistance of the magnet to to be tested upon closing the Key E, and keeping it permanently closed no current passes through the bridge wire F containing the chemical recording instrument but the current from the battery passes the branch C, and D, and A, and B.

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 38

That portion which passes through the branch, D, charge the Electromagnet If now while the magnet is charge the Key E be raised the current is broken and the induction discharge from the Electromagnet flows within the circuit formed by the wirs C D and F this current will be decompose the chemical solution and record itself permanently one of the worn points. if now the Key E, is closed and appozing induction discharge is thrown within the circuit formed by C, D, and, F, and is recorded on the other pen

Thus



without an ordinary relay of the Tillotson pattern used Extensively on the American Railroad telegraphs the record was made thus by successive opening and closing of the Key F

armature 1/8 inch from cores

Due to induction — closing

Due to induction — opening

armature in contact with core

Due to induction closing

" " " opening The following diagram will perhaps explain the action better

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 89

The resistance of the relay was 134 ohms total length of cores 5 inches diameter cores $\frac{9}{16}$ – diameter spool $1\frac{1}{2}$ – (see if correct

Second Experiment, Ordinary relay Phelps pattern used Exclusively by the W U Telegraph Co – Resistance 134 ohms drawn Core $\frac{1}{4}$ – in coils – – – total length of cores 3 inches armature one quarter inch away

Due to induction closed – – – –

" " " open – – –

with armature in contact due to induct closing – – –

with a special relay having 134 ohms Resistance with same dimensions as Tillatson Except length of cores which were but $2\frac{1}{2}$ inches armature $\frac{1}{4}$ owing to induction closed – – –

open –

armature in contact induction closing – – – – –

with a relay having but one spool arranged as shown in fig with 134 ohms R 1 inch long core $\frac{1}{4}$ with armature in contact the induction was so short duration and weak that a mark was scarcely perceptable on the most sensitive chemical

his next experiment was with a magnet of greater length the total length of core 10 inches diameter $\frac{9}{16}$ – R 134 no armature – induction closing – – –

open –

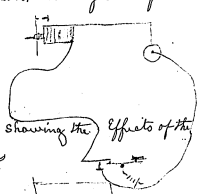
with Keeper in contact induction closing – – –

open –

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 40

Experiments were tried with magnets having a total length of several feet from which induced current flowed within the bridge circuit several seconds after the battery had been disconnected A comparison of the different records made shows that the induction action increases at the square of the length of the magnet and apparently at the square of the distance of the armature from the face of the cores These two laws will account for nearly every defect in Electromagnet instrumentation The number of convolutions increas the amount of induction as well as the mass of iron but if the proportionate increas of convolutions and increas of iron is made on every magnet the recorded magnets still show the law of the squares — are sent through as if the Tillotson relay as shown in fig —



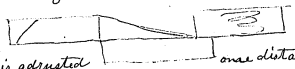
The record will be thus showing the effects of the induction in mutilating the signals

The induction due to closing the circuit does not show to the same extent as that due to opening but this can be explained that in this case the whole power of the current is used to

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 41

over-com the charge whereas in the bridge there were D. gives it a route free from induction influence hence the opposing Electromotive force of the indirect current balances it in the wire D hence no interference with the induction takes place in the bridge this diagram may Explain the dashes better



if the armature is adjusted one distance away from the face of the magnet the record will be This

Sent

Rec'd

if a very long magnet is inserted in place of the Intermediate the record would be Thus Sent

with ordinary more writing at 10 words per minute the record will be Sent

at

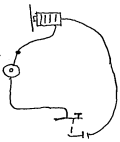
when a magnet having a core the total length of which is less than 1 inch attenuation of the mark cannot be perceived

See about putting in several and increasing the battery in proportion as increased R. See how will Effect it if the relay is arranged as shown in the following diagram no effect from induction Except on closing is Experienced

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

No 42

as there is no current for the induction to discharge in when the Key is opened and the record will be



Sent — . ---- . -- ---

Received — ---- -- ---

It must be remembered that when the current is sent through an Electro Magnet the induced current generated is in a contrary direction to that current and in the same direction on opening

3a) "Notes - Neutralizing Escape." Transcription. (42 pages; page 12 missing).

Note -

neutralizing Coils - show Rham
Method in ann form -
Show Smith's arrangement in good form
Show 3 modifications of my WU
arrangement.

* Say Bradley gal plate rubbed
with cloth will electrify the
needle and cause it to
stick to metal. Cider may be
discharged by lay the flat
of the hand on it - ~~shows~~ ~~get~~ good
~~cut~~ ~~of~~ Cut. also capacitor Cut
showing Coils & needle (MD)

Polarized Relays the battery polarized by a
Small Constant Battery

[1]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

MC – UC – Workwork battery charger
for Lechanche Cut & duplex –
Walkins Alarm –

Ann Dectual regular unit
" " Bugla Alarm

1 dig goods 20 capacements.
2 or 3 good unions
Self Starting regular –

Regular Repeater by lever & Embossing
paper –

Duplex – Having Sending receive his
own writing back

My two Ways Duplex Cut & duplex
with Way Station.

[23]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Disruption & cut my battery
also results of experiments on
prevention of diffusion if that
not so then the reason blue
kept down cause the action
takes place right at copper &
Blue Vitriol used as fast as
it tends to rise where
the in old way no action takes
place in rising fluid but
way down at bottom

Test that spring pulling with
spulling against explain why

That induction be greater on
Discs whose poles dont make

[3]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

good Earth for in that case
the distance from one wire
to the other goes over the same
material that it goes to
ground hence if the poles
being dry & makes poor
Earth on closing Conduction
takes place across the
arms but quickly cease
owing to the polarization of
the Contact parts of the
wire by the moisture of the
wood This would explain the
great induction on the Overland
wires running through dry desert

[4]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

One of the reasons why recent
on a ground wire is not
uniformly successful is
because of return currents
from other wires which when
exactly equal make the relay open
when distant man closes
& when not equal reduce
the effective working strength
of the distant current
secondly to the variation of
the return leakage owing
to the moistness of the feeding
batteries, this cause of
bad working in duplex
balances. The leakage is
is done by the plan now used but not in duplex [5]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

I was told at Greenwich that Earth Currents on Atlantic Cable sometimes potential 50 Volts Cell changes from N to P sometimes in less than ½ min.

Spark due to a great number of magnets in circuit may be greatly antihilated by putting sqr foot tin foil Each Etc Etc

663

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

placing thick paper -
between armature & screw
magnet up close so as
to get core near armature &
use powerful spring of paper
get very ~~quick~~ feeble signal.

⊃⊂ pointed platinum points
make better contact & longer
than flat ⊃⊂ because
in the case the oxide has
a clearance but with flat
points it has not -
Compressed platinum hydrolic
or very hard drawn gives
less spark best for mat

[7]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

10

prevalent Idea that sounds
points chang: ckt better than
relay etc gold leaf Expt
etc - show loss of part of
signal by changing line

Why opening joints should
be used about rebound
of all keys - produced by
the quick fall of Current
generating & break in
induction of magnet in
bridge showing

when held full power
with opening light

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Bad Connection in revolving shafts.

Vibrating points best

Compressed air & rounder-

decomposing batteries

Induction of Condenser Cable

Leyden jars decomposing Chemical action,

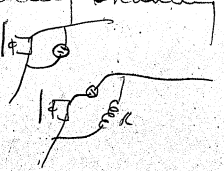
At Cable

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Say Chemical reminder spelled
instrument for investigation by
Companion —

~~get highest obtainable speed~~
~~through 1000 mile Race~~
~~with small Gally 136. Cup~~

Secondary Galley shunting
a relay



Thus

Describe effect show
Commutator

+

[10]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Automatic plan of putting number
way offices on wire & get signal
from main relay.

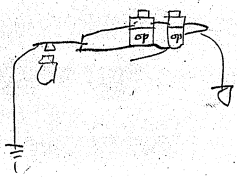
Work up system of Repeaters repeating
so as to Combine number of Branch
offices with main office messages
recd Embossed & harmonized
over main wire from Embossed
strip - say peculiar strip type
card & peculiar high Embossing

say old 4 & 1 Relays although only
3/4 long instead of speed waves
although short Relay allows of near
double ~~sp~~ no waves be used
600 used by Gould and Stock

[11]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Effect of polarized yet not



~~Provided a magnet and~~
see if no movement prevails
of a thing by vibrating P &
reversing Coils Double in Elect.
magnet shown

[12]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Resistance Coil of Kanaw
stone + plumbago graphite
also in glass hard rubber
etc =

Mention where a wire may
get grounded through local
connections with battery in
floor damp place - offer
wire for local running in
damp walls over gas
pipes etc =

Saw magnets been used at
Louisville having a total
length 11 miles worked both
on dry days & wet days [13]

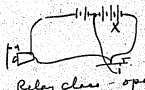
3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Secondary battery action on
~~[illegible]~~ hand wire
—.

How working with a
heavy battery through
a weaker opposing
battery gives weak current
on closing. - p + a test
Dec 27.

a quiet

Yes confirmed - This
little work



July 5th 1874

Closing Key Relay close - opening K Relay open &
will again close ~~[illegible]~~ after a time depending on the
amount of opposition of X battery = don't think Dahlia do this

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Compensating

Defect of reverse Current when strong enough to fully charge the wire & give an excess -

My Relay Worked by Displacing the polarized & wkg from the discharge of the magnet - also this

Why a polarized tongue. Should lay horizontal instead of perpendicular

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

1 9 1/2

Woods Bulton
Aulton Bulton
Hicks old
Hicks No 2
Hy Lalient
Bunnell
Hopkins
Milliken

dots & dashes
Marks can be burned in paper
at the rate of —— per min
by using a platina wire
& keeping hot by battery.
(Arm) Rigsta may be used for
perforating paper

[16]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Next to platina for contact Comes nickel - in most instances it is as good as platina & very much cheaper It is used for Contact rollers in Chronometric perforated paper transmission and gives good Contacts at 3000 Revolutions per minute.
0560000 revs

The discharge from the magnet in a Wheatstone receiving instrument interferes with the speed of how Chemical records,

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

The reason why the spark is so much greater on a local circuit with a Grove or Carbon battery than with a Callan's of the same strength is owing to the greater internal resistance of the Cattin - by shortcircuiting a main telegraph Battery compared of Grove or Carbon Battery we obtained a dazzling Electric light but if 20 ohms or even less be inserted as a part of the short circuit, were the spark is only just perceptible - This extra resistance is inherent in the Daniel,

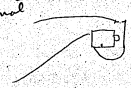
~~For many instances~~ hence for local circuits in different apparatus where a great number of Contact

[illegible]

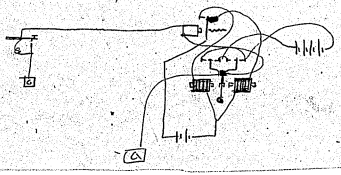
3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

are made the Collard should be used -

Movement - Pope had it thought used on his Pk Signal



Method of ~~receiving~~ getting reversal on a line at one station when from ~~the~~ battery at the distant station



[193]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Page – p 19 –

to make ordinary Ria fluid –

1 gal Sul a. 3 gal water –

in separate vessels dissolve

4 lbs Bichrom in 2 gal boiling

& add to other stirring thoroughly

The proportion of potash

sometimes made ⅓ greater

to make a more quantizing

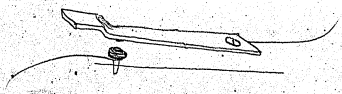
fluid add 1 gallon Water saturated

to 1 gallon Sul a

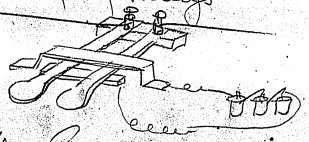
[20]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Amplikey



Reversing key Varley



Very Convenient

Very weak recq current sometimes the permanent Magnetism is equal to read current in that case the relay opens when key closed.

[21]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

24

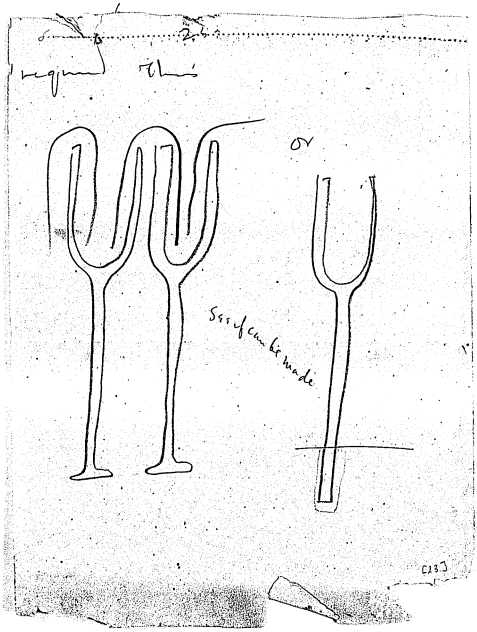
Reversed Current translators
Effect open ckt repeater,
Several RR signals get
discipline from Apparg

Test Battery

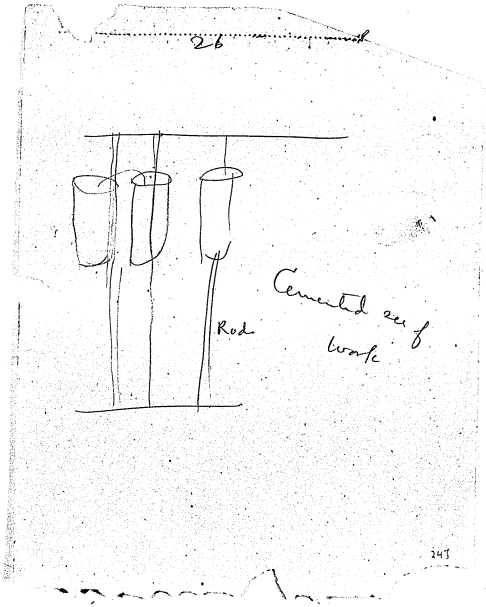
When Battery modulation

(223)

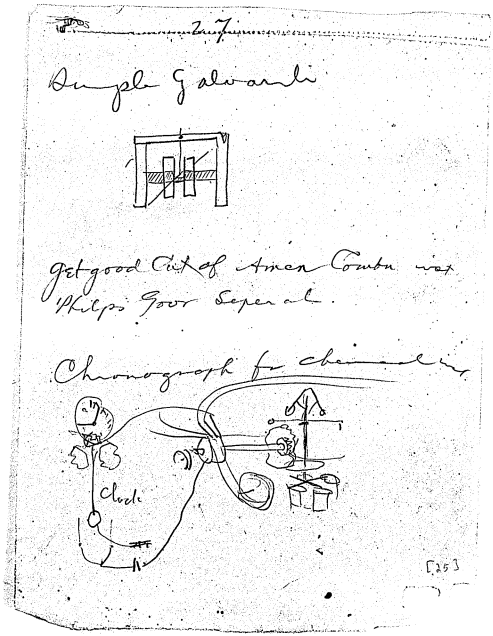
3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).



3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).



3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).



3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Duxant self adjusting Relay
Siemens Polarized Relay Amusing
Thomson Mirror
good ~~reversing~~ Key
Self Closing Keys
Van Horenburg's tension
Van Horenburg ~~Rattler~~ Rattler sounder
Switchboards all kinds
Mention when ~~testing~~ Long magnets
don't stand floor to insure
Electromotive fatty get bad
results dead lid magnet
Curtain sounds feeble

[25]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Mention as proposed by Little
weaker signal e.g. as to not
show static - say how works.
but this already done by
Bonnelli with very little
result - same person
added Condition but the
decrease speed method of
augmenting it. Experiments
made between W Ting gave
as highest ~~speed~~ ~~too~~ 90 w
per min on most sensitive
item paper - that was regarded
good result produced ~~this~~ result

[27]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

30,

in long circuits how a half
current should be sent for
dashes.
How first part of letter should
be longest

0000

How speed increased by using
European alphabet & close
spacing.

Show results on paper when
it is allemplied to works.
1917 Chemical Duplex.
Showing Automatic perforated
paper Duplex

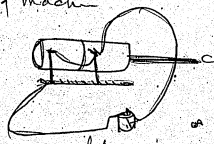
[48]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

31.

My perforator Old, new -
Modification by Pettibone Man
Roman perforator.
Old paper feed.
3 Key perforator,
Combination to produce Morse
Character Etc Roman
Embossing.
45 lever printer
Chemical printing Machine
Milwaukee -

Copying Machine



Thick ink & filling.

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

artificial Cable —

artificial Cable with magnet

artificial " with Siemens battery

Give experiment treated to

results with all —

~~Dry weather, large Gauge~~

Bradley spools —

test of strength compared

with other samples. Resistance

Get his table,

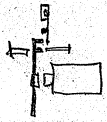
3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Duplex strong may have
way station receive
by placing a very short
relay shunted —
& the current from the
station sending is
double strength of
the other current

Duplex would be best
when relays repeat
arrange cut for that

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

a Relay is best with
spring joint this



Gutta percha made varnish
to coat arms of groove &
other lines in place
of asphaltum which
becomes spongy try it
asphaltum recommended
by Pope

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

35

Oil on Cotton balls X
Kerosene – Wooden Cover
prevent evaporation
Effectually – oil generally used
Cotton Seed – is soon oxidized
to make Carbon balls
last long while –
porous put ½ inch
thick – try –

X

[31]

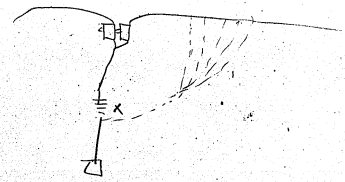
3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

36

Where there are several magnets in the same circuit ~~though not~~ whose ~~armatures~~ armatures are vibrated rapidly the stoppage of any one of these armatures is liable to alter the adjustment of the rest by reason of the increased or decreased strength of the induction currents generated by that magnet for instance several printing instruments whose types which were rotated by magnetism and adjusted properly three were thrown out of adjustment by holding down the armature of an extra magnet in the circuit

[34]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).



Resistance of leakage being water
to subject to polarization is decreased
by putting on battery X hence
when everything is equated for
the taking off of X will ~~allow~~
~~make~~ take off a Electromotive
force off of the water leakage

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

3b

hence reduces the resistance
so that when the distant
Current comes through not
so much will pass via
water leakage to Earth as
through metal leakage
but when it breaks
down the resistance of
the water derivation
although equaled more
of the distant current
will pass through leakage
owing to the peculiar
Effect of in reducing R of water

(36)

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

The advantage of
a non permanent Current
is that the leakage or
Cross fire is generally
all in one direction whereas
on the English lines
we receive Currents in
both directions so that
we have a current between
Nil + 30 Elements + on
the English lines between
~~nil~~ between 30 Positive + 30
negative or a ~~same of 60~~
disturbing effect of 60 Elements (37)

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

will always be a drawback to the first system,

Excessive underground work as well as the close proximity of one wire to another & the use of earth wires to prevent cross currents all of which are in use in England render the system far inferior to the American - say about Status Chang e [illegible]

3b) Pages 1-11 of (3a) in Edison's hand. (38 small pages).

Notes 1

(1)

Neutralizing Escape show Kramer method in a new form

Show Smiths arrangement in good form show 3 modifications of my 1911 arrangement

Say Bradleys gat-plate rubbed with cloth will electrify the needle and cause it to stick to metal circular may be discharged by say the flat of the hand on it. Show good cut also separate cut showing coils & needle 000

Polarized Relays the bar being polarized by a small constant battery

Near Cracker Clockwork battery changer for Declanche cut & description.

Walkins Alarm

A Mr District Regular with
" " Burglar Alarm

1 Doz goods Escapements. 2 or 3 good minions Sif. Sterling Regulator

3c) Transcription of (3b) plus some additional material. (18 pages).

No. 2.

Notes

Register Repeats by lever & Embossed paper

Duplex turning sending current his own working back

May two ways Duplex Act & description with my battery

Description & Cut my battery also result of experiments on prevention of defection if that not so then the reason Blue kept down came the action takes place right at Sofaper & Blue Vitriol used as fast as it tends to rise When in old way no action take place on rising fluid but way down at bottom.

Test that Spring pulling with & pulling against. Explain why

What induction be greater on lines where poles dont make good Earth for in that low the distance from one wire to the other goes over the same material that it goes to ground. hence if the pole be very dry and makes poor Earth on closing conduction take place across the arms but quickly ceases owing to the polarization of the contact parts of the wire by the moisture of the wood. this would Explain the great induction on the Overland wires running through dry desert.

3c) Transcription of (3b) plus some additional material. (18 pages).

Notes At a 3.

One of the reasons why receiving on ground wire is not uniformly successful is because of return currents from other wires which when Exactly Equal make the Relay Open when Distant man closes & when not Equal reduces the Effective working strength of the distant current.

Secondly to the Rectifications of the return leakage owing to the vagaries of the feeding Batteries. The cause of bad working in duplex. balance the leakage is done by the plan now used but not in duplex.

I was told at Greenwich that Earth currents on Atlantic Cable sometimes potential 50 Daniels cells Change from A to P. sometimes in less than ½ minute

Spark due to a great number of magnets in circuit may be nearly annihilated by putting 5 or 6 oz. tin foil Each side etc etc.

placing thick pieces of paper between armature & forcing magnet up close so as to get core near actuator and use powerful Spring of paper get very feeble signals

Pointed platina points makes better Contact & Longer than flat.

3c) Transcription of (3b) plus some additional material. (18 pages).

Note — 8/2/11

because in this case the Oxide has a clearance but with flat points it has not.

Compressed platina Hydralai or very hard drawn gains lies spark best for Inst. prevent. Silver Platinum under points close etc better than Relay etc gold leaf Experiments etc — Shows loss of part of Signal by changing lines

why spring points should be used about Resound of all kips — proved by the quick fall of current generation & break in underline of magnet in bridge showing

---

When held full power —
With spring left —

The pressure of contact points increase of speed must have increased pressure — Copper better than platina — Oil good at first Oxidized by spark dissolved in Excess the Oxide (black) which drips quickly on ~~stopping~~ few minutes & hardens in place.

3c) Transcription of (3b) plus some additional material. (18 pages).

No 5

Notes

Show chemical records of a break wheel at same pressure at different speeds – See what increase must be given for increase of speed to get good record bad connection in revolving shafts.

Vibrating points best

Compressed air sounder. Secondary battery
Reduction of condenser cable. Lay down Secondary chemical action
Atlantic cable

Say chemical recorder splendid instrument for investigation by comparison –

Sending battery shunting a relay

& thus

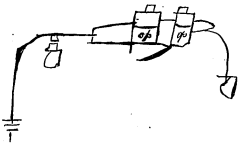
3c) Transcription of (3b) plus some additional material. (18 pages).

Notes No 6th

Describe effect shown course of Currents.
Automatic flam of putting number of way offices on wire & get signal from main relay.

Work up system of register repeating so as to combine number of Branch offices with mains offices message rec & Embossed & transmitted over main wire from embossed strips – by peculiar strong paper used & peculiar high embossing.

Say old G.S. Relays although only 3/4 long extended speed waves. Authors short slotting relays allow of nearly double the number waves be used. 600 used by Gold & Stock Effects of polarized. yet not.



See if in movement precaution of acting by vibrating P & reversed coils double in Electro magnet shown.

3c) Transcription of (3b) plus some additional material. (18 pages).

Note 7

Resistance Coils of Kansas silver & plumbago, rapidly also on glass hard rubber etc =

Mention where a wire may get grounded through local connections with battery on floor damp places. office wire for local running in damp walls over gas pipes etc =

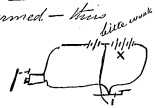
Saw magnet used at Somerville having a total length of 11 inches worked bad on dry day day nothing of wet day

Secondary battery acting on land wire —

How working with a heavy battery through a weaker opposing battery. gives weaker current in closing P & A test Dec 27th

Against

yes confirmed — this



July 5th 1874

3c) Transcription of (3b) plus some additional material. (18 pages).

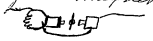
Notes No 8

Closing key relay close opening K relay opens & will again close. after a time depending on the amount of polarization of X battery. I don't think Daniels do this.

Compensating

Defects of reverse currents when strong enough to fully clean the wire & give an Express —

My relay worked by displacing the polarized & working from the discharge of the magnet — also thus



Why a polarized tongue should lay horizontal instead of perpendicular.

Woods Button
Authors Button
Hicks Old
Hicks No 2
Hicks Latest
Bunnell
Haskins
Milliken

3c) Transcription of (3b) plus some additional material. (18 pages).

Nos 9th

dow & dustes

Marks case bi ronnen ive paper at the rate of
— miles per minute by using a stationive iwire
& keeping not by battery (Morse) Register may be used
for perforating paper.

Resto to platina for contact comes market in most
instances it is as good as platina and very much
cheaper. d is used for contact Roller in perforated
paper transmissions and give good Contact at 3000
words per minute or 60000 waves.

The discharge from the magnet in a wheatstone receiving
Instr interfere with the speed, Now Chemical records

The reason why the spark is so much greater on a local
current with a grove or carbon battery than with a cell and
of the same strength, is owing to the greater internal resistance
of the latter - by short circuiting a main telegraph battery
Composed of grove or carbon batterys we obtain a dazzling
Electric light but if 20 ohms or even less be inserted
as a part of the short circuit wire the spark is
only just perceptable - this extra resistance is inherent in
the Daniels

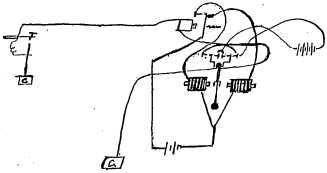
3c) Transcription of (3b) plus some additional material. (18 pages).

Table of Contents

Here for local circuits in different apparatus when a great number of contacts are made the callard should be used —

Movements — Pope had it. Morse used one like O R Pope

Method of getting reversal on a line at one station when from no battery at the distant station.



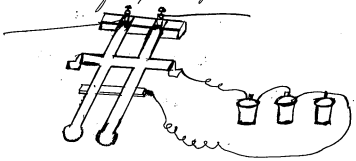
Pope page 19 =
To make Ordinary Red fluid —
1 Gal Sul phuric Acid = 3 Gal water — in separate vessels dissolve 5 lbs Bichromate of Potz in 2 Gal boiling & add to other Stirring thoroughly the preparation of potash

3c) Transcription of (3b) plus some additional material. (18 pages).

Sometimes made 1/5 Greater to make a more quantity of fluid add 1 Gallon Water Saturated Solution of Bichromate - to 1 Gallon Sulphuric Acid

Simple Key

Reversing Key Varley



Very Convenient

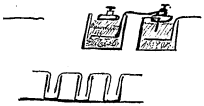
Very weak receiving current sometimes the permanent magnetism is Equal to the current in that Case that Relay opens When Key closed

3c) Transcription of (3b) plus some additional material. (18 pages).

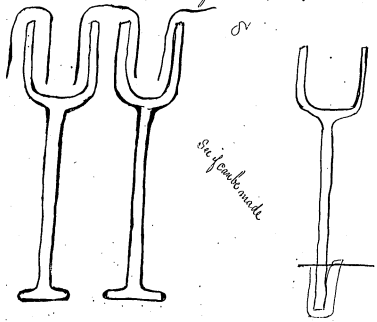
(12)

Reversed Currents translators suffers open circuit repeater - Normal R.R. signals get description from Spang.

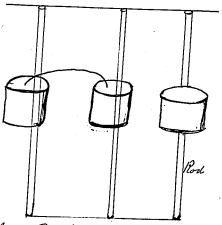
Test Batters.



When better insolation - required this.



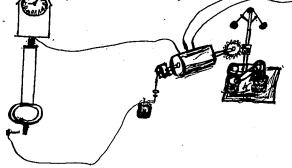
3c) Transcription of (3b) plus some additional material. (18 pages).



Simple Galvanometer

Get good cut of American Combination instr. Phillips Governor
Separate.

Chronograph for Chemical Instr.



3c) Transcription of (3b) plus some additional material. (18 pages).

Duranto Self Acting Relays
Siemens Polarized relay American Style
Thomson Mirror
good receiving key
Self closing keys
Van Hoevenburgs union
Van Hoevenburgs Rattler Sounder
Switchboards all kinds.
Insulation when testing long magnets don't shake floor
to increase Electromotive force battery - Get bad results don't
test magnets within several feet of needle.-

Machine as proposed by Little - weaker Signals so as
to not show static - Say how works - but this already
done by Bonnelli with very little result - Same person
Adds condensor but this decreases speed instead of
Augmenting it. Experiments made between Washington
and New York. Give as highest speed 90 words per minute
on most sensitive iron paper that was readable
good Varnish produces this result (Phones) in long circuits
how a half current should be sent for dashes.
How first part of letter should be longest
0000

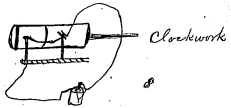
3c) Transcription of (3b) plus some additional material. (18 pages).

15

How Speed increased by using European alphabet & close spacing.

Show results on paper when it is attempted to work Pertit chemical Diplex = Showing Automatic perforated paper duplex.

My perforated Old (new)
Modification by Peekskill man
Roman perforator
Old paper feeder
3 Key perforator
Combinations to produce morse character Eli Roman
Embossing
4 5 lever printer
Chemical printing machine
Milwaukee
Copying Machine



Thick ink Iron filings

3c) Transcription of (3b) plus some additional material. (18 pages).

Artificial Cable —
Artificial Cable with magnet
Artificial Cable with Secondary batterys.
give Experiments & recorded results with all

Bradleys Spools —
Tests of Strength comparison with silk. Same resistance —.
Get his table

Duplex Steams may have way Stations receive by using a very Short relay shunted & the current from the Station sending is double strength of the other current.

Duplex would be best when relays repeat
Arrange cut for that.

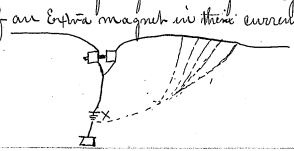
A. Relay is best with Spring points thus.

3c) Transcription of (3b) plus some additional material. (18 pages).

Guttapercha thick Varnish to coat arms of grove & other zincs in place of Asphaltum which becomes Spongy
try it Asphaltum recommended by Pope.

Oil on Callaud bulk nuisance – Wooden Cover prevents Evaporation – Effectually – Oil generally used Cotton Seed – is soon Oxidized to make Carbon battery last long while porous pot 1/2 inch thick –
Dry.

Where there are several magnets in the same circuit whose armatures are vibrated rapidly the stoppage of any One of these Armatures is liable to alter adjustment of the rest by reversing of the increased or decreased strength of the induction Currents – generated by that magnet, for instance several printing instruments whose type wheels were rotated by magnetism only and adjusted properly these were thrown out of adjustment by holding down the Armature of an Extra magnet in their circuit



3c) Transcription of (3b) plus some additional material. (18 pages).

Resistance of leakage being water & subject to polarization is decreased by putting on battery X hence when Everything is Equated for the taking off of X will take off a Electromotor force of the water leakage.

Hence reducing the Effect

So that when the distant current comes through not so much will pass via - water leakage to Earth as through metal leakage, but when X is on. it breaks down the resistance of water leakage X although Equated more of the distant current will pass through leakage owing to the Effect of X in reducing R of water.

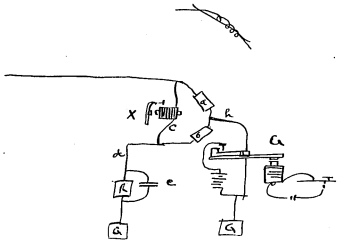
One Advantage of American permanent current is that the leakage or crossfire is generally all in one direction where as in the English lines. We receive currents in both directions so that we have a current between Nil & 30 Elements & on the English lines between 30 positive & 30 negative on a disturbing Effect of 60 Elements where as present insulated will always be a drawback to fast Systems

Excessive underground work as well as the close proximity of one wire to another & the use of Earth wires to prevent cross currents all of which are in use in England render their System far inferior to the American. Story about Statics

Change increased

3c) Transcription of (3b) plus some additional material. (18 pages).

If the receiving instrument be a Mirror galvanometer the induced Currents generated are very weak and will scarcely disturb the working but if the ordinary Morse relay is used the induced Currents will produce a multiplication of the signals the shorter the cores of the receiving Magnet are the less the ~~disturbance~~ induction. figure 21 shows this method,



3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

A B are adjustable resistance coils, which independent of the other Connection form a shunt around the receiving instrument. d is the artificial line, R the rheostat for make the resistance Equal to the line and e the Condenser to produce a static Charge upon the artificial line Equal to balance the static Charge upon the regular line, G h is the battery wire placed between at the central point of resistance of the shunt. G is the usual device for connecting + disconnecting the battery, If the rheostat R is adjusted so that it shall have the same resistance as the line wire, and the Condenser e has the same

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

Electrolytic Capacity as the line. Then there are two wires one on one side of the instrument and one on the other side of the instrument both having the same resistance & electrolytic Capacity. If the shunts a & b are equal in resistance and the battery is connected to the bridge by the upper movement of the sounder lever. it follows that the current will divide equally upon the regular & alternate line. and none will pass down the bridge wire c Containing the receiving instrument as the resistance on both sides are equal and there is no cause for a deflection of galvanometer. If no condenser was connected to the alternate line that portion of the current due

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

to the static charge of the line would pass through the instrument, O
The resistance of the artificial line can be reduced to less than the resistance of the line and the differences compensated for by increasing the resistance of the ~~resis~~ Rheostat B, but the ~~Electro~~ the decrease of resistance between the ~~the~~ armature of the Condenser & the other of course decreases the electrostatic capacity of the ~~line~~ artificial line d. When signals are received from the distant station works one half of the current passes through the coil a to the ground via h the other portion through the relay. thence through b to the ground and a small portion through d to the ground.

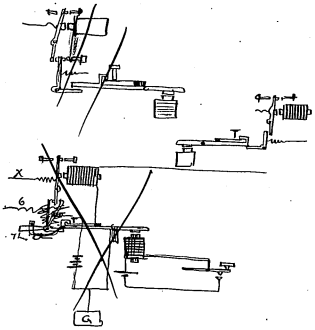
3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

When the signal ceases the induced current from the magnet circulates with the current formed by a.b.c thus preventing the instantaneous charge and discharge of the relay and modulating the signals in the exact proportion as the length ~~of~~ of the core of the magnet and number of the convolutions are increased and the resistance of the derived circuit. This effect is partially compensated for by the slight static reluctance changes which are generated by the small quantity of current which passes to the ground through d.

Mr Stearns is the inventor of another very ingenious modification which

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

is shown in figure —.



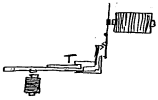
The ~~bala~~ effect of the outgoing current in this method is compensated for by mechanical means. a is a lever 6, a ~~special~~ a retractile spring having a tension equal to the effect of the magnetism ~~due~~ in the

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

relay due to the outgoing Battery
This lever comes in Contact &
rests on the Extension of the relay
lever when the Sounder lever is
raised and the ~~Contact~~ Contact
instant the ~~battery~~ points
seperate and the Battery B'
is thrown on the line
The advantages of this method
is that if the Equation be not
perfect no extra signals
will be thrown in as in
the Double Coil duplex
but the Effect will be to
~~reign when the effect~~ ~~although the adjustment~~
of r l. be adjusted frequently
Mr Stearns describes no
method of Counteracting
the Extra Charge.
The charge may be counteracted
mechanically as shown

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

as fig.

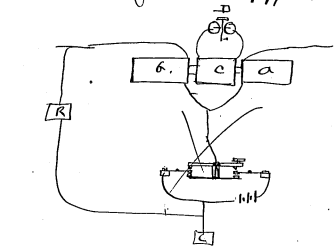


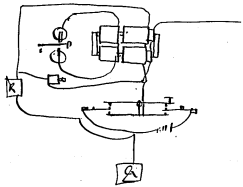
The following ~~systems~~ methods were devised by the author and are ~~on~~ an illustration of the enormous number of combinations which it is possible to make with telegraphic apparatus. A portion of them have serious defects, while others are ~~as nearly perfect as it is possible at the present time~~ while others will perhaps be found as ~~are~~ more perfect than the methods now in use.

The ~~first~~ method which I shall now describe is worked entirely by induction, which requires less perfection of balance

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

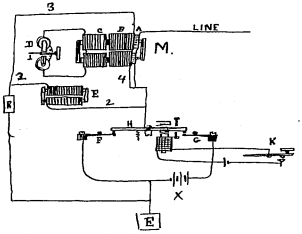
and has a greater working margin besides allowing the use of apparatus which is nearly self adjusting. This method is shown in figure ///





3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

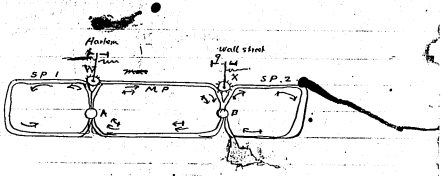
29.



M is a long Electromagnet upon which are wound the coils A.B. in opposite directions to one another, The Coil A is in the main line circuit and the Coil B in the artificial line R is the resistance Coil adjusted so that its resistance including the coil B equals the resistance of the line, C is an Extra Coil not in connection with Either Circuit. The two free ends of

3d) Pages 13-15 of (3a), here numbered 22-29, in Edison's hand, preceded by different material on pages 20-22. (10 pages).

2 (1878)



~~M P is the main water pipe~~; we will suppose that this water pipe Curant extended from Wall St to Harlem, and that A and B were ~~dynamo~~ Engines & reservoirs by which a Current of water ~~of~~ any desired amount might be made to circulate in the direction ~~the~~ as indicated by the arrows.

W and X are two water wheel provided with levers, which ~~open & close~~ strike between fixed points

4)

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

3 Duplex

Spiral springs are secured to these levers to keep them against the proper point when no water passes,

The object of the secondary water pipe circuits SP 1 SP 2 will be explained ~~explained present~~ ~~obvious~~ when we proceed ~~a little~~ further.

Now suppose that a stream of water was thrown into the main pipes by A, it would but half fill the water pipes and traverse it on the direction shown by the arrows. The action of the passing stream of water would be to slightly move both the wheels and bring their levers from one fixed point to the other, ~~hence by alternate~~

When the water is stopped the levers are drawn back by the

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

~~and~~ spring; so far the ~~message~~ signal has been received at both the home and distant station. It remains now to trouble how the wheel ~~at the~~ X ~~m~~ is left to respond to A, and the wheel W prevented from doing so.

You will notice by referring to the diagram that the water circuit S.P.I. is so arranged upon the opposite side of the wheel that the stream of water which is injected into S.P.I. from A. tends to turn the wheel in a direction just the opposite to that injected into M.P. hence if the amount and speed of the water in both the main & secondary pipes are equal it is obvious that the wheel W will not move; ~~and~~ as long as these ~~eq~~ balances are obtained any ~~kind~~ amount of water ~~or the~~

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

Travelling at any speed
~~speed which it circulates in the~~
~~two Circuits~~ may be sent from A
into both Circuits without moving
the wheel W. [illegible] the distant
station the water [illegible]es the wheel
as none of it can cir[illegible]late in the
Secondary Circuit o[illegible] that
station.

We will now suppose that a
~~stream~~ of water from A is circulating
~~on~~ the SP1 and the main Circuit.
If the wheel X is moved to the
left hand point, W remaining
unaffected ~~as above as~~ shown before.
If now the apparatus at B is
so arranged that ~~the~~ water may
be injected into the the main pipe
& secondary circuit in the same
direction as that injected by A.
the effect of the ~~extra amount of~~ injected by main circuit MP water
on the wheel X is exactly balanced
by that which circulates in the circuit
SP.2. & does not prevent the wheel X from turning by the water sent from W
but ~~this excess of~~

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

6

the water injected at MP always. The galvanometer which obtains at MP & SP.1. and the excess from B forces the lever over to the left hand [illegible]

It will be seen that it is not necessary that the current should flow in opposite directions to obtain these messages, [illegible]al,

It is possible to arrange the work from B could be made,

In the electric duplex the secondary circuits are replaced by the Rheostat in which are coils of fine wire, so arranged that any less such an amount of fine wire may be inserted sufficient to work retard or set up a resistance to the passage of the current equal to that offered by the line,

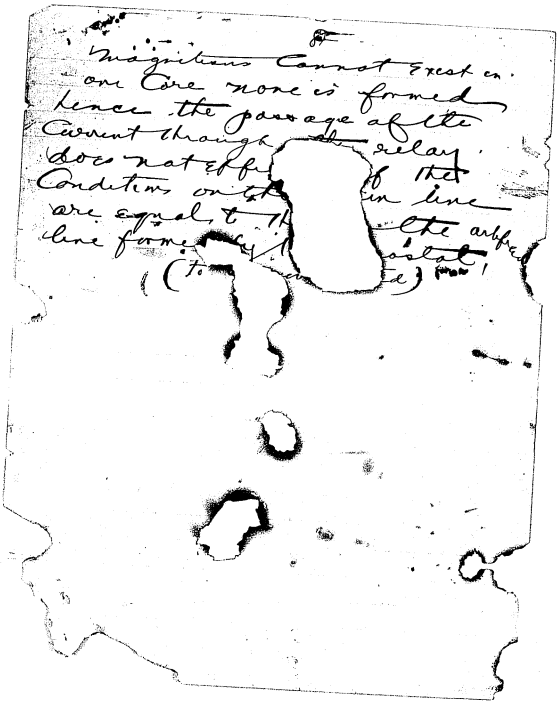
The water wheel is replaced by a relay having double coils of wire so that the current passing over both the line

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

7

and secondary current in the same direction may pass through the two coils of the relay in opposite directions so as to in the case of the water wheel the effect is claimed by allowing the beams of water to on current the opposite side of wheel. The current of a battery passing through one of the coil on the relays tends to make one end of the iron core take a north magnetism while the other iron core takes a south magnetism. But the effect of the current through the other coil is just the opposite of this, it tending to make a north magnetism in the same core as the other current is endeavoring to make a south magnetism and as the two

4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).



4) "We will suppose that . . ." (7 pages; incomplete; Edison's hand).

2. Duplex

the effects of the transmitting battery upon the receiving relay at the same terminal.

The second feature, is to preserve the continuity of the circuit and equality of resistances in the act of signalling*

Mr Stearns method is shown in figure.

A is the duplex relay for receiving the signals from the distant end. The iron cores of this relay are wound with two distinct wires insulated from each other,† and so connected that the current from the battery G passes through each wire in opposite directions, One wire or bobbin is placed in the main line circuit, while the other is placed in the artificial line circuit.

† Two bobbins are shown in the engraving to convey a clearer idea,

* Invented by Professor Moses G. Farmer of Boston in 1868 & adopted by Stearns,

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

3. Duplex

When the rheostat in the artificial line is adjusted to offer a resistance to the passage of the current, equal to that offered by the main line, then the passage of the current from the main battery G over both lines will produce no effect on the relay A. as the tendency of the current circulating within the main line bobbin is to produce say a north and south polarity in the soft iron core, while the current in the bobbin connected to the artificial line tends to reverse this action. hence the cores will not become magnetized.

Should the resistance of one circuit be less than that of the other, more current will pass through one bobbin than the other and the cores will become magnetic to that extent, ~~and~~ attracting the armature

The main battery is connected and disconnected from the two circuits by the lever H operated by a magnet placed in a local circuit ~~wh~~ This circuit is opened an ~~closed~~

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

4 Duplex

by the Transmitting Key K.

The Lever H is connected to earth. A spring a to which is connected both the main and artificial circuits is secured to the lever H by a block of vulcanite,

When the lever is unattracted by the local magnet this spring is in contact with the bent end of H, completing the circuits to earth. If the is attracted by the local magnet. the spring a is is thrown away from the lever by coming in contact with the point c. The continuity of the circuits is still complete, but the battery a is placed on both circuits,

Mr Stearns inserts a small resistance in the earth wire at R to lessen the spark at the moment when the spring a comes in contact with the point c and before it is seperated from the bent lever,

It will be observed that neither the continuity of the circuit ~~is~~ broken or the resistances materially changed in the act of signalling.

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

5 Duplex.

and as the current from the battery G when permanently connected to line produces no effect upon the relay A. it follows that if the current on the main line be increased over that circulating on ~~in~~ the artificial line by connecting the battery at the distant station the cores of the relay will be magnetized and attract its armature, The same action takes place when the battery G is disconnected for then there is no current on the artificial line while the current from the distant station is free to magnetize the cores of the relay

So far this arrangement answers for ~~short~~ aerial circuits of 100 miles or less, but on longer circuits, the ~~phenomena~~ of static induction tends to destroy the balance which must be maintained between the two currents passing through the coils of the relay ~~A~~. To preserve the balance Mr Stearns attaches the condenser C

5a) "The effects of the transmitting battery . . ." (10 pages; incomplete; Edison's hand).

6 Duplex.

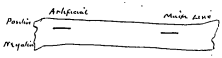
to the artificial line so as to obtain ~~the~~ as much static induction on the artificial ~~line~~ as is necessary to balance within the coils of the duplex relay the static induction of the main line, this method of attaching the condenser is somewhat defective as it only partially compensates for the static induction of the line nevertheless it is effective except on very long circuits of considerable Electrostatic Capacity

The action of the static induction in this particular case is well illustrated by the chemical strips.

When the condenser C is disconnected from the artificial line & the battery B be put to in connection with the two circuits, the line wire being free from static induction a dash will record itself upon the chemical strip. as in fig.

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

7. Duplex



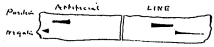
If the main line has considerable electrostatic capacity, the record will be as shown in fig

~~Static induction~~ the inductive current on closing is added to that of the battery and the relay levers from a short circuit this of course destroys the balance as the first part of the wave passing within the circuit of the artificial line is not augmented, upon disconnecting the battery, a static discharge is obtain which circulates in a direction opposite to the battery current, this wave which at first strong gradually ceases as shown on the slip, the longer the circuit the greater the length of time will the discharge take to fall to nothing, If the condenser is now added to the artificial line as shown in figure. The slip will

This produces smoother movement of the relay levers & gives a fuller signal

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

present a different appearance, as in figure



When Stearns manner of connecting the Condenser, does not produce the same effect as is produced upon the line, the difference is scarcely perceptible on short lines, and the compensation is practically sufficient but as explained before when the line is very long this method of compensation is defective,

The line itself is a condenser or accumulator of static electricity which is distributed on along its entire length, and the charge upon each successive mile from the battery is less and less, ~~but the~~ and a certain time is consumed in charging it. But the condenser being in direct contact with the battery (with the exception of the relay resistance) is almost instantly charged. On disconnecting

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

9 Duplex

The battery. The condenser is almost instantly discharged owing to the low resistance connecting its two armatures, but it is not so with the line. The static charge must pass through a considerable resistance which of itself is an accumulator hence the current will flow on the line some time after the condenser has completely discharged itself, and this excess of current circulating in one line although not powerful enough in some cases to give a distinct movement to the relay lever is sufficient to mutilate the signals from the distant station as shown in fig

Sent
Received

~~On when received by sound~~, will certain letter such as m q etc will be turned into L and n.

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

10 Duplex.

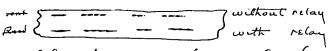
To more closely produce or imitate the conditions of the main line upon the artificial one, the condenser should be divided up into several parts and inserted between the several resistances composing the artificial line as shown in figure — This will distribute the static charge over the whole of the line and the length of time which it will take the charge to fall from maximum to zero will be equal to that of the line ~~dis~~, and a perfect balance of forces become possible,

It does not matter what condition obtains on the regular line so as it is imitated upon the artificial line ~~As an~~ the balance will be maintained for instance if an ordinary relay be inserted in the line wire. ~~the~~ it will generate an ~~discharge~~ inductive current which destroys the balance

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

11 Duplex.

But if a relay of the same character be inserted in the artificial lines the balances will be restored, although this does not compensate for the action which the ~~discharge~~ inductive current has on the receiving ~~so~~ relay independent of the balance ~~on the distant relay produces;~~ (12) (13) Mutilation of signals as shown in fig.



But this effect is not so bad as the destruction of the balances.

There exists another defect in this form of Duplex which is the Self induction of the relays themselves no self induction is produced upon the home relay by the outgoing current if it be well balanced. But with the current from the distant station it is different. To this current the Double coil

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

acts as an induction coil ~~so to speak~~.
The primary coil being in connection
with the line while the secondary
coil or the bobbin connected to the
artificial line, when the distant
battery is connected. the tendency
of the line wire bobbin is to induce
a wave into the artificial line
coil ~~of an opposite character~~ which
is augumented by the action of the
condenser, These waves secondary
currents reacting upon the relay
tend to emulilate the signals, Several
hundred of Mr Stearns Duplex are in use in this country
The author dispenses with the
condenser an produces the same
results with an electromagnet,
fig" shows this arrangement,

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

13 Duplex.

M is an electromagnet with twice or thrice the resistance of one of the bobbins upon the relay. It is provided with an adjusting device by means of which the magnet may be made to approach or recede from a fixed armature .c. If the magnet be adjusted ~~very near to the fixed armature its self induction will be increased~~ so that the faces of its cores will touch the fixed armature. the self induction of the magnet will be at its maximum and it will be decreased as the magnet recedes from it. ~~The equation of the static charge.~~ ~~cobta~~ Supposing the current of the battery G be placed permanently on the line ~~the operation will be as follows upon disconnecting it~~.

The line and magnet becomes charged now upon disconnecting the battery the static charge acting upon the main line bobbin tends to magnetize the cores of the relay ~~as has already~~ in the manner

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

already described. but at the same time the induction current from the magnet m circulating within the closed circuit formed by the wires 3 4 and 5 and the bobbin tend to produce an opposite effect and the relay remains unaffected, If the main line gives a strong discharge then a discharge equal in strength may be generated in the electro magnet m by adjusting it nearer the fixed armature,
Upon closing the inductive current is added to that of the ~~main~~ battery current in that portion of the circuit formed by the bobbin & wire 5.
~~It~~ It is obvious that this device forms a much more convenient economical & effective arrangement for static equation than the condenser

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

15 Duplex

When used in connection with submarine Cable or land lines of great static Capacity the magnet A should be several times as Long as the receiving magnet, otherwise the induction Current will cease before that of the line,

By this arrangement a local circuit operated by a second battery may be used which is not possible with the Condenser, as in figure — —

5a) "The effects of the transmitting battery . . ." (14 pages; incomplete; Edison's hand).

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1 Duplex

The Duplex principle was invented by Dr Gentl, ~~The first practical Duplex was invented by Mssrs G Farmer of Boston in But the modern Duplex and the one which~~ But the first practical Duplex was invented by ~~G B~~ Mr Stearns ~~of~~ Boston,

As Duplex instrumentation is one of considerable importance at the present time and a branch which illustrates the vast number of combinations which may be made to produce the same result and the explanations it gives to several phenomena hitherto not well understood will be my excuse for the great ~~length~~ length number of pages devoted ~~to~~ this subject

103 (2)

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

2 Duplex

The author has made an immense number of experiments in this branch of telegraphy and feels that he is ~~competent to~~ of which the following ~~articles are made~~ are abstracts from, and most of the devices described in the following pages are the result of experiment.

In that class of Duplex ~~by~~ which signals are sent in the opposite direction at the same time, the main feature is to neutralize all the effects which are produced by the action of the outgoing current upon the receiving instrument at the same station. The second feature is to preserve the continuity and equality of resistances in the act of signalling*

* first invented by Farmer in — & adopted by others.

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

3 Duplex

Mr Edarni method is shown in figure

A is the Duplex relay for receiving the signals from the distant station, †It is wound with two distinct wires arranged in such a manner that the current from the main Battery G ~~shall~~ passes through Each wire in opposite directions ~~to th~~. One helix is in the circuit of the main line. The other is in the circuit of the artificial line,

When the Rheostat in the artificial line is adjusted to offer a resistance to the passage of the Current equal to that offered by the main line. The passage of the current from the Battery G over both lines will produce no effect on the relay A, as the tendency of the main line bobbin is to produce a north and south pole in the Cores of the relay while the effect of the bobbin in the artificial is just the opposite & neutralizes this tendency and no magnetism is produced,

†. I show two helix of wire so as to illustrate the principle more clearly but the wires are usually wound side by side

9b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

4 Duplex

should the resistance of one circuit be less than the other. then the balance more current will pass in the circuit of less resistance and the excess will manifest itself ~~by on the sela~~ by attracting the armature of the relay with a force proportionate to the excess of current passing in the circuit of lowest resistance,

H is a lever operated by a local magnet in a local circuit broken by the transmitting key K.

The ~~lever H~~ lever is connected to Earth, a is a spring ~~insulated from~~ secured to a piece of vulcanite on the lever H. The spring and is connected to the jointed circuit, main & artificial line, When the lever H is unattracted by the local magnet the spring ~~a~~ is in contact with the Earth through the end of the lever H ~~is in contact point in connection with~~ ~~Harmonic Galleries G.~~ ~~but when the~~ the current from the distant station will have a clear route to the Earth. When the lever H is attr

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

4 ~~Duplex~~

is attracted by the local magnet, the spring is disconnected from the Earth lever and Earth is connected to the point c and battery to Earth, ~~R1 and R1 are~~ R1 is a small resistance coils inserted to reduce ~~prevent~~ the spark at the moment when the separation of the spring a from the lever takes place as at this moment the battery is "short circuited" It will be observed that in signalling that the battery 9 is connected & disconnected without breaking the circuit or materially altering the resistances, and as the action ~~Effects~~ of the battery is not upon receiving relay it follows that if the strength of the current ~~within~~ on the main line is increased by adding the battery at the distant station, that the balance will be disturbed and the relay lever will be attracted Each time the battery

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

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6 Duplex

at the distant end is connected
on disconnecting the battery G,
the relay still responds to the
current of the distant battery.
So far this method answers for short
lines ~~as between Telford~~ of 80 and
100 miles, but on longer lines another
influencing cause arises ~~which~~
called static induction and the
object of the Condenser C is to
compensate for this phenomena &
secure the balance necessary
perfect signalling.

12 (2)

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

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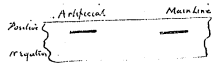
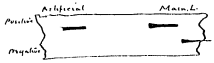
7 Duplex.



If the main line has considerable electro-static capacity the record will be as shown in fig on closing and opening

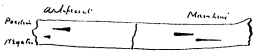


115 (1)

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

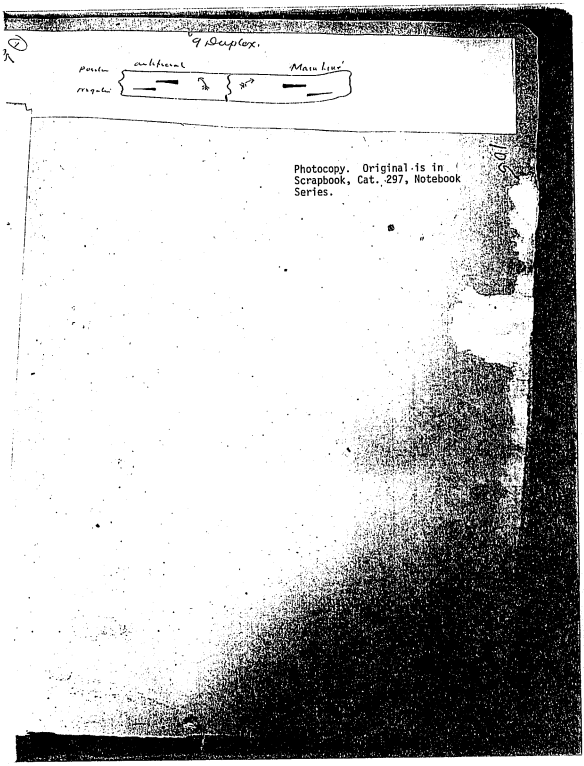
8 Duplex

present a different appearance



It will be noticed ~~by referring to the~~ the records both of the main and lines present nearly the same app The charge & discharge from the condenser same strength as that of the lin is of very short duration ~~as wel discharge~~, The reason of this is Charge and discharge of the l Effected through a considerab while that of the condenser ~~is so con of can discharge~~ ~~This result~~ is through a very slight resistance If the condenser be divided up int parts and distributed ~~also~~ bet resistance coils as in fig th and discharge may be made equal to that of the main fig will show the record whe balance is perfect.

5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).



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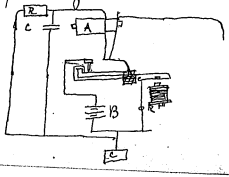
5b) "The Duplex principle . . ." Another version of (5a). (9 pages; incomplete; Edison's hand).

No 1

In a Duplex apparatus by which signals can be transmitted in opposite directions the main feature is to neutralize the effects produced by the outgoing current upon the receiving instrument the second feature is to keep the main line while signalling nearly at a constant resistance this result was first obtained by Mr Stearns on the ordinary Telegraph circuits the mode of obtaining a constant resistance was devised by Messrs J Farmer Many years ago and subsequently adopted by Mr Stearns Stearns method.



6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 2

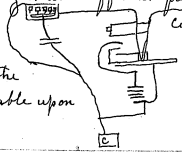
A is the Duplex relay for receiving the signals from the distant station it has double coils wound around its cores in opposite directions to each other so that the current from the battery B passes through one helice in one direction to and through the other helice in an opposite direction one helice is in the line wire the other helice is in an artificial line of the same resistance made so by a set of resistance coils X if the line on which this relay is placed is but a few miles in length the artificial line composed of resistance coil will exactly imitate and produce the same effects as the line wire when the resistance of both are equal the battery B when thrown in circuit by the attache of the sounder lever transmits a current of the same strength upon the regular and also upon the artificial line these currents passing through the two helice of the relay tend each to produce a magnetism in the cores opposite to each other consequently no effect is produced upon the relay any excess of current due to the battery At the the distance station passes through one helix only hence the relay responds to any excess of current either on on the regular or artificial line now if the line upon wich one helix of the the relay is placed is long the extra effect produced in wich is not produced upon the artificial line although both may have them

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 3

Duplex

Some resistance This extra effect is called static induction ~~and any equal amount which~~ and this static induction must be produced upon the artificial line before an exact balance can take place to produce the same static charge upon the artificial as produced upon the line Mr Stearns inserts a condenser in the manner shown in figure one when the current from the battery B is thrown upon the regular and artificial line the line and condenser both produce a static charge in the same direction as the battery current balancing themselves in the double helices of the relay while the battery remain on the line which is in fact a condenser + condenser become statically charged so that when H is is disconnected a static charged flows out of the regular and artificial line in the opposite direction to the battery current but as before owing to the reverse direction in wich the wire on the relay is wound the neutralize each others effect from the condenser may be varied as shown on figure 2 we by connecting it at different points of potential



This method of connecting the condenser does not produce the same effects as that produced upon the line the difference is scarcely noticeable upon short lines

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 4

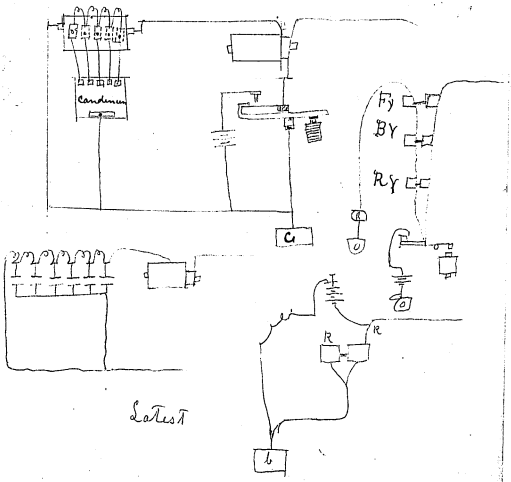
and the imitation is practically sufficient but when when the line is very long and its static capacity very great This method of connecting the condenser doe not give a perfect balance the line itself being a condenser or accumulator of static Electricity distributed along the entire length it follows that each successive mile from the battery receive less charge than the one before it the condenser is of the artifical line is immediately charged being in direct contact with the two poles of the battery. when the battery is disconnected the condenser is quickly discharged but not so with the line the static charge accumulated at a distance from the battery must pass through a resistance which of itself is an accumulator of static Electricity this charge will ~~if~~ flow out of the line some time after the condenser on the artificial side has discharged itself which it does through no resistance this will of course throw the two circuits out of balance and interfere with the signal from the distant station the Effect being to strengthen and weaken these signals as for instance the letter H on closing and opening would be recorded ----.

more closely imitate or produce the conditions of the mane line upon the artificial line the rheostat should be composed of a large number of small resistance coils between wich a few leaves of the condenser is inserted

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No. 5

This will distribute the static accumulation throughout the whole length of the artificial line and the time of change and discharge can be made the same fig. 3 shows this method



6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

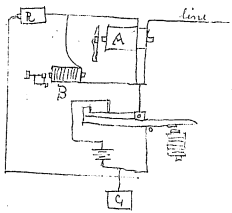
No 6

it is obvious that if the phenomena upon line any Telegraph circuit is exactly imitated and produced upon the ~~[illegible]~~ artificial circuit that we will produce a perfect Duplex Telegraph as regards this one particular – it is known when the two circuits have been balanced that if an ordinary relay is inserted in the regular line the balance will be partially distroyed owing to the induction discharge from that relay but if another relay of the same kind and of the same restance is inserted in the artificial line this effect is equated for but this relay in the regular line will weaken the first part part of a dash recieved upon the relay from the distant station and prolong it after the battery has been disconnected at that end but this effect is not so noticable as that produced by distroying the balance there exists another defect in this form of duplet which is the cause of considerable trouble which is the self induction of the relay itself there is of course no self induction due to the outgoing battery but with the incoming current of the distant battery the case is different the helix in the the artificial circuit act as a secondary coil and the helice connected to the line is operated by the distant battery conforms the primary – The accumulations connected to the artificial line

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 7

to augument the strength of the induction waves induced into the secondary helice by the primary were their no accumilation conected to the artefecal circuit the strength of the wave would be little but these serve to increase its strength $\frac{1}{2}$ which reacting upon the relay makes the recieved signals very inegular the amount of induction may be determined by insurting a dilicate polarized relay in the artifical line when the betery B is not being operated the dithor dispences with a condensers to obtain an artifical line and produces the same effect by the inductive action of an electro magnet fig 4 shows this arrangement



B is an electro magnet twice or thrice the resistance of one of the helices upon the relay it is also longer than the coils of the relay it is provided with an armature which

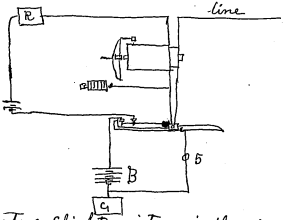
6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

the cores or adjusted some distance from them the purpose of which is to increase or decrease the length of its induction discharge the Close the armature the cores of the Electromagnet the greater will be the length on discharging time. when the battery B is connected permanently no induction action takes place in the relay the electro magnet B is charged and the regular line also at the moment of disconnecting the battery the line discharges its static Electricity through the inner helice of the relay but at the same time the magnet B sends an inductrici discharge equal in strength and length be the static charge from the line through the second helice thus preserving the balance the circuit in wich the induction discharge from the magnet has only the resistance of itself and one of the helices of the relay the induction circuit is shown by the dotted lines in this case the induction from the line helice of the artificial line has less Effect than when the condenser is used the charging discharging time of the magnet B can be almost indefinitely increased by increasing the length of the magnet

by this arrangement a local circuit operated by a small battery may be employed which is not possible with the condenser system thus in fig 5

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 9



Mr Stearns insents a slight resistance in the wire 5. for the purpose of preventing the entire shorten-circuiting of the battery and also to lessen the spark at the contact points if this resistance be too small and several duplex circuits are worked from the one battery as is usual in the American closed circuit system signals will be quite irregular on all and especially upon the longer circuits as either one or the other of the contact points of the several duplex are constantly short-circuiting the battery this rapidly exhausts it down increases its internal resistance to a point where with the two circuits of one duplex and several duplex working from the same battery with leakage and intermittent short-circuiting reduced the external resistance lower than that of the battery when this takes place the opening

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

and closing of one duplex circuit will be noticed on other duplex working from same battery at the distant station but not so appreciable at the station where the battery is the remedy for this is obvious the authors duplex Relay a discription of which was published in the Telegraph several years ago was at first adopted by Mr Stearns but subsequently abondoned for the Siemens Solski Double coil relay the former consisted of two magnets facing each other with the armature between them the effect of this relay is that a perfect balance cannot be obtained as the approach of the armature towards one or the other magnet disbrays it and reason which is that if a given current is sent through line separate magnets one of wich is partaly magnetized the latter will change sooner. A difference - the quantity of the iron or in the length of magnet or the receiver of convolution owing to self induction will occassion difference in the charging and discharging times of the 2 magnets if the equalizing magnet is adjusted nearer the armature than the line magnet and the difference being equated for by increasing the resistance of the circuit in wich the equaling magnet is placed the effect of the close approach of the armature will increase the secondary charges within the equaling circuit and increase the discharging and discharging time if all these conditions could be compensated for this form of magnet would undoubtedly be

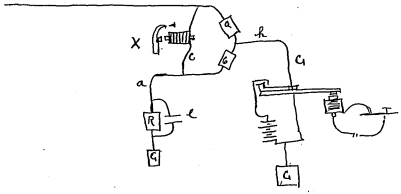
6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

Shown in Fig No 11 the double coil as no currents would be induced into the secondary on equaling circuit by the primary main line coil Mr Stearns has recently introduced a modification of his duplex which modification consists in placing the receiving instrument in the bridge wire of the wheatstone bridge the advantages of this modification over the other plan is short it does not depend upon the — of the apparatus employed it will work as well with a mirror galvanometer as with the ordinary morse relay no special form of apparatus is required except resistance coils the disadvantage is that the receiving instrument is rendered less less delicate a portion of the working current need from the distant station passing through the shunts around it the main disadvantage being that the shunt from a route for the discharge of the inductive currents of the receiving instrument thereby enormously increasing the charging and discharging them of the receiving — A. B. are adjustable resistance coils which independant of the other connection form a shunt around the receiving instrument D is the artificial line — R the rheostant for make the resistance equal to the line and E the condenser to produce a static charge upon the artificial one to balance the static charge upon the regular line H is the battery wire placed at the central point of resistance of the shunt CI is the usual ~~device~~

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

No 12

for connecting and disconnecting the battery if the rheostat R is adjusted so that it shall have the same resistance as the line wire and the condenser E has the same if the receiving — be a mirror galvanometer the induction currents generated are very weak and will scarcely disturbe it working but if the ordinary Morse relay is used the induced currents are produced a mutalation of the signals shorten the cores of the receiving magnet are the lys the self induction figure 2 shows this method



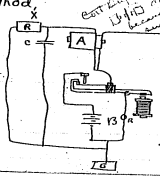
— capacity as the line then there are two wires one side of the instrument and one on the other side of the instrument both having the same resistance and — capacity if the rheostate A B are equal an resistance and the battery is connected to the bridge by the upward movement of the Saunders lever at.

6a) "In a Duplex apparatus . . ." Transcription. The last page transcribes the first of (3d). (12 pages).

In a Duplex apparatus which transmitted ~~messages~~ signals by ~~messages~~ can be in opposite directions the main feature is to neutralize the effects produced by the outgoing current upon the receiving instrument. The second feature is to keep the main line at a constant resistance, ~~The first was~~ This result was first obtained by Mr Stearns on the ordinary latch circuits, The mode of obtaining ~~signalling through~~ a constant resistance was ~~invented & patented~~ devised by Moses G Farmer many years ago This ~~mode has~~ ~~been~~ successfully adapted by ~~Mr~~ Stearns.

The reason why a Key that made well in at Boston did not make satisfactorily here was that the relative resistance of the two sides of the circuit was not nearly equal.

Stearns method



No 2

A is the Duplex relay for receiving the signals from the distant station, it has double coils wound around its cores in opposite directions to each other, so that the current from the battery B passes through one helice in one direction and through the other helice in an opposite direction. One helice is in the line wire the other helice is in an artificial line of the same resistance ~~as the line wire~~ made so by a set of resistance coils X If the line on which this Relay is placed is but a few miles in length. the artificial line composed of resistance coil will exactly imitate and produce the same effect as the line wire, ~~and of~~ when the resistance of both are equal, The battery B when ~~connected to the line~~ thrown in circuit by the ~~closing~~ attach of the sounder lever transmits a current ~~both on~~ of the same strength upon the regular and also upon the

The artificial line. These currents passing through the two helices of the relay tend each to produce a magnetism in the cores opposed to each other consequently no effect is produced upon the relay. ~~On account~~ any excess of ~~excess~~ current ~~coming from~~ due to the battery at the distant station passes through one helix only hence the relay responds to any excess of current either one ~~the~~ on the ~~line~~ ~~line~~ or artificial line.

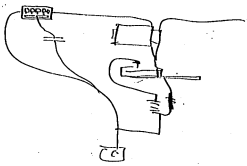
Now if the line ~~be on~~ upon which the relay is placed ~~is long~~ is long. The artificial line ~~there is~~ an extra effect produced which is not produced upon the artificial line although both may have them same resistance. ~~Therefore~~ This extra effect is called static induction. and any equal or nearly equal static induction must be produced upon the artificial line before an exact balance ~~of effects~~ can take place.

6b) Pages 1-7 of (6a) in Edison's hand. (11 pages).

~~If in this arrangement the regular line as extra artificial line is substituted for the regular line~~

To produce the same static charge upon the artificial as ~~upon the line~~ is produced upon the line, a Condenser ~~must be connected as shown on fig. 1. the capacity for generating a static charge~~ Mr Stearns inserts a Condenser in the manner shown in figure one. When the current from the battery B is thrown upon the ~~line~~ regular and artificial line. the line and condenser both produce a static charge in the same direction, as the battery current. balancing themselves in the double helices of the relay while the battery remain on the line. & which is not so (Edison) condensers become statically charged so that when it is disconnected a static charge flows out of the regular contacts. the line ~~wire and artificial~~

~~line~~ in the opposite direction to the Battery Current, but as before owing to the reverse direction of ~~the two~~ wave in which the wire on the ~~Du~~ Relay is wound the neutralize each other effect on the relay. ~~But~~ f the discharge from the Condenser may be varied as shown in figure 2. ~~At~~ by connecting it at different points of potential
potential



~~It is obvious that~~ This method of connecting the condenser does not produce the same effects as that produced upon the line, the difference is scarcely noticeable upon short lines

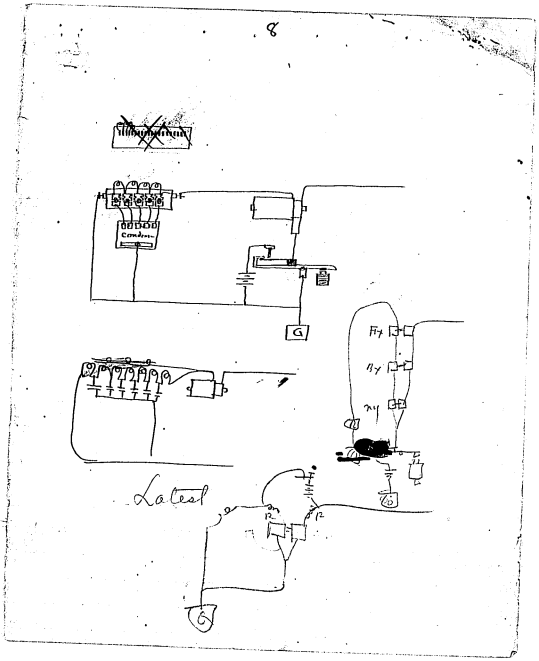
and the imitation is practically
sufficient. but when the line is
very long and its static capacity
very great. this method of connecting
the condenser ~~does not give~~ does not give perfect balance
The line itself being a condenser
or accumulator of static electricity
distributed along its entire length
it follows that each successive
mile from the battery, less the charge than
the one before it. but the condenser
of the artificial line
is immediately charged, being in direct
contact with the two poles of the
battery. When the battery is disconnected
the condenser is quickly discharged
but not so with the line ~~it must~~
discharge the static charge accumulated
at a distance from the battery must
pass through a resistance which of
itself is an accumulator of static
electricity. This charge will flow
out of the line some time after the
condenser on the artificial side has
discharged itself which it does through

7

no resistance this will of Course throw the two Circuits out of balance and interfere with the signals from the distant Station & will the Effect being to strengthen & weaken these signals as for instance the letter H .... on closing & opening would be recorded ....

To more closely imitate or produce the Conditions of the main line upon the artificial line the ~~Resistance~~ Coil Rheostat should be composed of a large number of small resistance Coils. between which a few leaves of the Condenser is inserted ; this will distribute the stated accumulation ~~at a great number of~~ throughout the whole length of the artificial line and the time of charge and discharge can be made the same of fig 3 shows this Method =

6b) Pages 1-7 of (6a) in Edison's hand. (11 pages).



6b) Pages 1-7 of (6a) in Edison's hand. (11 pages).

It is obvious that ~~a lines of great~~ of the phenomena ~~length and of great static capacity~~ ~~obtained upon~~ upon the line any telegraph circuit is exactly imitated or and produced upon the artificial ~~line connected to~~ circuit that we will produce a perfect Duplex Telegraph as far as regards the one particular = It is known that when the two circuit have been balanced of an ordinary relay is inserted in the regular line. the balance will be partially destroyed owing to the inductive discharge from that relay. But if another relay of the same kind and of the same Resistance is inserted in the artificial line. this effect is equated for, But this relay in the regular line will weaken the first part part of a dash received upon the relay from the

6b) Pages 1-7 of (6a) in Edison's hand. (11 pages).

distant station and prolong it after the battery has been disconnected at that end. But this effect is not so noticeable as that produced by destroying the balance.

There exists another defect in this form of Duplex which is the cause of considerable trouble which is the self induction of the Relay itself. There is of course no self induction due to the outgoing battery but. ~~The helice of the~~ with the incoming battery the case is different. The helice ~~conn~~ within the artificial circuit acts as a secondary coil and the helice connected to the line operated by the distant battery forms the primary. The accumulators connected to the artificial line serve to augument the strength

of the inductive waves induced into the secondary helix by the primary were there no accumulators connected to the artificial circuit the strength of the wave would be little but these serve to increase its strength ½ which reacting upon the relay makes the received signals very irregular. the amount of induction may be determined by inserting a galvanometer in the circuit into which the battery is to be put. The author dispenses with a condenser upon the to obtain an artificial line, and produces the same effect by the inductive action of an Electro magnet. Fig 4 shows this arrangement.

polarized

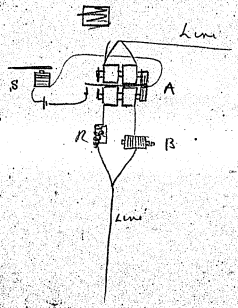
~~amount of induction may be [illegible] by inserting a delicate galvanometer [illegible] artificial line when [illegible]~~

Induction Relay.

~~Such~~ This is a very effective and delicate Device and is found to work well in practice, ~~to a great self adjusting~~ magnet It will work between the greatest extreme of holding power without requiring adjustment and has the peculiar advantage of working under any condition, it is far more delicate than the same relay worked by induction from a secondary Coil for in the latter Case the induced Current is of very high tension & very weak whereas in the former Case the ~~strength~~ Current is of a tension not much greater than the main Current &

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

has almost the same power
figure — shows the device



A is the polarized Relay with
durable helix preferably [?]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

~~wound~~ two wires wound side by side the current which passes through each in opposite direction like a Duplex but shown as separate bobbins so as to convey a clearer idea of the connections.
The two pair of bobbins are then arranged so that the current in one branch of the main line shall pass through in one direction while the current in the other branch shall pass through in an opposite

[3]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

direction, within one branch is included an ordinary Electro-magnet with 100 or 200 Ohm Resistance with its armature in Contact or it may be an ordinary Relay - in the other branch is a resistance which must be so adjusted that the resistance of both branches are exactly Equal or of such a resistance that the Effect of the main Current is Exactly balanced in the polarized Relay A.

[4]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

If now the plain resistance was substituted for the magnet B. opening & closing the main current would produce no effect on the polarized relay: but when the magnet is in the circuit on closing the ~~Cu~~ main current an inductive discharge from the magnet B circulates within the local circuit (as far as the induced current is concerned) the first part of which is nearly as strong as the main current, this current ~~pas~~ unlike the main

[5]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

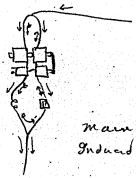
5

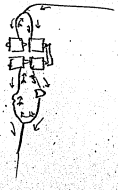
Current passes through the two helices on the polarized relay in a direction necessary to produce magnetism in the cores, if now the main current is broken an induced current of the same strength but of an opposite character to the current generated on closing the main current circuits with the closed circuit & throws the tongue over to the other point - therefore — will show the direction of the ~~current~~ induced current on closing

[6]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

The main Current + freq. on
open





7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

7

The polarized relay is self adjusting for any current above which does not fall below the point which it necessary to produce an induced current to move the polarized tongue –

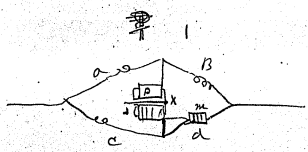
The induced magnetism may be increased by increasing the Resistance, or length of magnet & decreased by discommodating the armature from the face of the Core shortening the magnet or reducing the resistance

This relay will give good signals with 10 cups of battery at each end of a 300 mile No. 9 wire circuit

[8]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

in ordinary weather -
figure shows another plan
whereby the double Coils are
dispensed with -



The Resistance of all the
branches a b c d
are equal; When the
main line is closed no
Current Except the induced

[9]

7a) "Induction Relay." (9 pages; incomplete; Edison's hand).

Currents from the magnet
in passe through the Slot
polarized Relay Z. P. This
Current circulates in the
closed Circuit formed by
the Wires B. D, H. X

The inductive Changes may
be increased in strength
by replacing ~~putting in the~~
~~magnet in the branch~~
a in place of the
The resistance in the branch
a with an Electromagnet
of the same resistance -

Unbound Notes and Drawings, 1874-1878

1874. Telegraph - Notes and Essays (NS-74-002)

[These pages should follow the document on reel 7, frame 217]

It will be seen that one of the
branches must contain a device
which will generate induced
Currents while the
other branch must be a
neutral or non producer
of these Currents, were
it otherwise both branches
containing Electro-magnets
these induced Currents
would not circulate within
the ~~[illegible]~~ for Circuit
formed by the 2 branch
fig 1. but pass on the

Unbound Notes and Drawings, 1874-1878

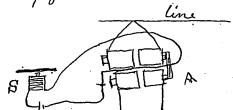
1874. Telegraph - Notes and Essays (NS-74-002)

[These pages should follow the document on reel 7, frame 217]

No 1 Copy original by THC

Induction Relay

This is a very effectual and delicate device and is to found to work well in practice as a magnet it will work between the greatest extremes of battery power without requiring adjustment and has the peculiar advantage of working under any condition, it is far more delicate than the same relay worked by induction from a secondary coil for in the latter case the induced current is of very high tension and very weak whereas in the former case the current is of a tension not much greater than the wave current and has almost the same power — figure shows this device



A is the polarized Relay with double helices preferably two wires wound side by side the currents which passes through each in opposite direction like a Duplex but show as separate bobbins so as to convey a clearer idea of the connections — The two pairs of bobbins are arranged so that the current in one branch of the main line shall pass through in one direction while the current in the other branch shall pass through in an opposite direction, within one branch is included an

7b) Transcription of (7a). (4 pages).

No 2

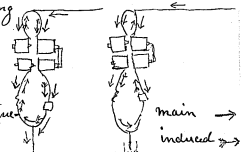
ordinary Electromagnet with 100 or 200 Ohms Resistance with its armature in contact or it may be an ordinary relay in the other branch as a resistance which must be so adjusted that the resistance of both branches are Exactly Equal or of such a resistance that the Effect of the main current is Exactly balanced in the polarized Relay if now plain resistance was substituted for the magnet B, opening ~~[illegible]~~ ~~[illegible]~~ closing the main current would produce no Effect on the polarized relay but when the magnet is in the circuit on closing the main current an induction discharge from the magnet B circulates within the local circuit (as far as the induced circuits concerned) The first part of which is nearly as strong as the main current this current unlike the main current passes through the two helices on the polarized relay in a direction necessary to produce magnetism in the cores if now the main current is broken one induced currents of the same strength but of an opposite character to the current generated on closing the main current circulate with the closed circuit and throws the tongue over to the other point or ___ will show the direction of the induced current on closing

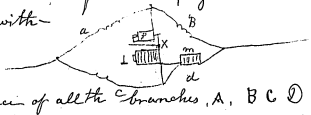
7b) Transcription of (7a). (4 pages).

No 3 Copy

The main current fig one opening

The polarized relay is self adjusting for any current which does not fall below the point which it necessary to produce an induced current to move the polarized tongue the induced magnetism may be increased by increasing the resistance or length of magnet and decreased by disconnecting armature from the face of the core shortening the magnet or reducing the resistance this relay will give good signals with 10 cups of battery at each end of a 300 mile No 9 wire circuit in ordinary weather — figure shows another plan whereby the double coils are dispensed with





This Resistance of all the branches, A, B C D are equal when the main line is closed no current except the induced currents from the magnet — pass through polarized relay, P, this current circulates in the closed circuit formed by the wires, B D, & X The induction changes may be increased in strength by replacing the resistance in the branch on with an electromagnet of the same resistance

7b) Transcription of (7a). (4 pages).

No 4

It will be seen that one of the branches must contain a device which will generate induction currents while the other branch must be a section of non production of these currents were it otherwise both branches containing Electro magnets these induced currents would not circulate within the circuit formed but pass on the line

7b) Transcription of (7a). (4 pages).

No 2.

Morse Telegraph contends with Line

1 Secondary battery action

2 Static charge

3 Earth current Battery current

4 Earth currents

5 induction

6 cross fire

7 Variability of

8 polarization leakage

9 Leakage

10 Relay discharge

11 Earth currents

12 These one with another produce Secondary phenomena

action of light on the whole polarization battery.

Instrument

1 one Self discharge of relay in leakage deterioration

2 oxidization of points

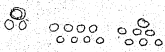
3 Shaking of relay points

4 magnets time of local magnet

8a) "Morse Telegraph contends with Line," page 2. Transcription. (1 page; incomplete).

6

6. Inertia of moveable parts
7. Double Currents due to rebound of key levers.
8. Oxidization Key points,



It is very probable that the moisture on a insulator when but slight that the passage of a Current repells each globule or breaks it up in small globules repellant of each other & then through the Current give a momentary charge (10) Slate

Note

4 of Moveable parts

7 Double currents due to rebound of Key levers

8: oxidization key points

It is very probable that the moisture on a insulator where but slight that the passage of a current repells each globules and breaks it up in small globules repellant of each other and then breaks the current give a momentary charge (10) Static

8c) Transcription of (8b). (1 page).

No 1

Chemical paper well made Iodide paper should give a mark through 500 000 ohms with one Daniels cell – The Resistance of Iodine paper is when moved continuously to prevent insulation of the Styles by free iodine is another resistance decrease as the battery increases See if so Manganese salts have much less delicacy than The most inferior ferrocyanide paper The most perfect writing is obtained when it is almost dry for Then there is no spread of writing and no mechanical attenuation which although extremely slight with Iodine Solutions get Effect and give the signals a pointed appearance Attempts have been made to substitute a recording roller in place of the points so as to allow of a greater press but unsuccessfully on account of the covering of chloride matter which it receives when the first signal is sent – when Sulphanet of plasm is used polarization of the pens greater than with the ferrocy and the sulphide of iron which still remains on the pen after a signal insulates the pen and it is not uninsulation until the current has passed for some time through breaking down the insulation ammonia chloride sal 20 a gill of water add teaspoonful nit Ammonia to this add what is held on small knife blade of arsenic chlor Sodium the paper is white with iron pen marks are blue with tin pens they are yellow at first but soon turn

No 2

purple – (Purple of Cassius) the sensitiveness increased by adding slight amount of bichloride mercury less than one chloride sodium but there appears after a few hours a continuous line running through the signals the Chl. sodium does not answer as well as the nitrate of Ammonia the Excessive amount of Iodide of pottassium which is necessary to be used to give delicacy to the paper led me to believe that only a certain ammount was necessary to give a good mark the Excess merely acting to reduce the resistance of the paper but I found that by using less Iodine and adding conducting salt in the same proportion as the lessen amount of Iodine that the sensitiveness was reduced to the proportinat amount of Iodine in the paper the signals received on Iodind paper when quite damp fade within one hour but if really dry paper is used the marks are perceptable for several weeks afterwards vanishing the strips to prevent the air from comming in contact with the free Iodine does not prevent the disappearance of the marks – with the fused Cyanide Solution of a little starch be added the marks have a deeper color – The resistance of very dry Iodized paper through through a moon Gal of 3500 ohms is will one cup 50 000 will five cups 100 000 Iodized paper will show a good black dot with one cup of battery through

No 8

one million ohms in 6 Seconds will five cups it
gives a good continous marks capable of recording
100 words per minnut decreasing the thickness of the
paper does not probely decrease its resistance
of sulphocyanide of potassium to which is added
Hydrochloric acid or murriat Tin —
Quit formale white marks be recorded on Read
back grannd Logwood wood Solutions find out more
about = it sometimes accurs that in compass galvanomter
having a glass cover and insulated that the needle is
attracted to the Metalic index this is caused by cleaning
the glass with a cloth the glass becomes Electrically
Eccited and the needle is attracted it may be discharged

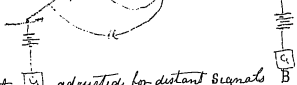
No 1

In the American System of working by permanent currents considerable difficulty is experienced in doing weather from the escape current or leakage especially at terminal stations This current which is in proportion to the leakage becomes so powerful in wet weather that the armature must be moved a considerable distance from the face of the cores to obtain a practical adjustment and also to reduce the self induction of the magnet it self the latter being the main trouble as the ground on one side and the combined derivations or leakage on the other side of the relay in which the induced currents can circulate hence placing the armature at a greater distance from the cores reduces the strength of the self induction at the square of the distance it also brings the armature out of the influence of the permanent current. but at the same time the magnetic effect of the received currents is reduced at the square of the distance On wires of very bad insolation and on which relays of considerable length are used the distance of the armature from the face of the cores sometimes must be $\frac{5}{8}$ of an inch to obtain a practical adjustment hence not one tenth of the current is utilized which could be if the armature was nearly in contact with the core, the shorter the cores of the magnet is the nearer the armature may approach the higher the resistance the greater

Photocopy. Original is in Scrapbook, Cat. 297, Notebook Series.

No 2

will be the effect of the leakage current numerous attempts have been made to render the effect of the leakage current nugatory on the receiving relay — among which may be mentioned Kramers and Smith — Kramers device is described in Deut Schellen and Sabine Smiths device is shown in fig — C



A. is a relay magnet adjusted for distant signals B is another relay which may work an ink recorder or act as a sounder etc both are in the main circuit when the current ducted the distant battery crosses the armature of the relay, A. flies a way from magnet and makes contact with the points E. and short circuit or shunts the magnet B. by the wires C. D. when the distant current is off the relay lever of A. is drawn forward the shunt is removed and the current due to the escape and distant current energizes the magnet B but a local might be passed through the magnet B. and produce precisely the same effect and it still leaves the evils above enumerated untouched in this 10 (1)

10) "In the American System . . ." Transcription. (2 pages).

~~Market~~ Printing Telegraphs.

Within the last few years an entire new Branch ~~in the class~~ of Telegraph instrumentation has been created in this Country. ~~The latest market prices~~

~~The~~ All the ~~last~~ quotations of the New York Stock Exchange are distributed to upwards of 1000 brokers offices during the day from a Central Office by means of a ~~Modification of the Original House Printing Telegraph~~ diminutive ~~step~~ step printing Telegraph instrument, and they have proved of great value to the Commercial Community as well as a source of profit to the Companies who operate them. At the present moment there is about 3 million of dollars invested in this Enterprise branch of Telegraphy. There are several classes of printers used. ~~The~~ Two of which are based on the Patents of the author with the Exception of

11) "Printing Telegraphs." (9 pages; Edison's hand).

printer,

one,
In a printing telegraph it is necessary to perform two distinct operations ~~over~~ to rotate the type wheel and actuate the printing lever. The manner of accomplishing this result over one wire are mostly described in fig. . . . . Chapter or
Movements —— figures —— —— —— —— —— —— Shows more clearly the ~~application of the~~ principle of the instruments which have ~~produced~~ the best results. been adopted,
fig - is the first self acting one wire machine of this class invented, and allthough not at present greatly used. on account of the capricious action of the polarized switch is undoubtedly the most perfect device for producing two movements at a distance on one wire by magnetism

11) "Printing Telegraphs." (9 pages; Edison's hand).

Sprunli

as it does not depend upon an even
& rapid transmission of waves to effect
the result but will act with the slowest
as well as the most rapid pulsations,
for the ~~plan~~ device no applies to a printing telegr
is already described in a
previous Chapter (Fig 9) Suffice it to say,
that when positive Currents are transmitted
(10) interruptions of a permanent positive
Current, is made the polarized bar of the
polarized switch magnet is thrown to that
side which shunts the positive diver
magnet out of Circuit, and producing
nothing interferes with the proper action
of the polarized bar switch, This magnet
would never become active until
a negative Current was sent when
the switch bar would fly to the other
~~side of the~~ Contact point & shunt the
type Wheel magnet. One of the reasons
why these switches were not practice
on their action was that the stiff bars

11) "Printing Telegraphs." (9 pages; Edison's hand).

4 printer.

were not sufficiently magnetized for
of pole if a permanently magnetized bar
be adjusted by a very strong magnet.
the force with which it will be moved
will be in proportion to the magnetism
in the bar, if it were an iron bar and
centered between the two magnet cores.
The centering of one core would be to
pull it one way and the bindering of the
other core to pull it the other way
now hence it would not move
but if it have a slight directive force
or permanent magnet it will be drawn
with a force to one pole or the other, according
to the polarity of the magnet. with a
proportional to the permanent magnet
no matter how strong the magnet may
be. This was not well understood when
the switch were first introduced and
the permanent magnetism was so feeble
that the most powerful current with
such magnet would the bar would
scarcely make contact with the
right or left point necessary to

11) "Printing Telegraphs." (9 pages; Edison's hand).

shunt the magnets and produces the diverdiscuits, Another defect was that the lightning depolarized the switch bars & necessitated remagnetization - from this reason Instruments using this device have now been almost abandoned. With strongly magnetized bars this device is as reliable as any device used in telegraphy.

(note mention that owing to the small quantity of electricity been that no evil results are produced by the passing of the switch bars from one point to the other even when in use.)

~~In abandoning the polarized switch~~

Fig. shows an entire new principle for obtaining the two movements on one wire and this principle has now been adopted in all the one wire machines now in use. This principle is based on the fact ~~discovered~~ noted & [illegible] by the Author that when rapid reversals were transmitted within a closed circuit containing an Electromagnet and an a polarized

11) "Printing Telegraphs." (9 pages; Edison's hand).

6 pence

magnet the lever of the polarized magnet would be actuated with considerable force while the attraction of the ordinary Electromagnet for its armature would be scarcely perceptible,

This device is shown in figure —

The author first used a very short ~~Electro~~ polarized magnet one siemens principle in conjunction with a long Electromagnet but subsequently added a shunt around the long Electromagnet equal in Resistance to the magnet itself, ~~etc~~

Without the shunt it requires that the reversals should be sent within the circuit at a certain speed ~~after~~ any slower speed will allow the Electromagnet to act. But with the shunt. The discharge of the Electromagnet itself would be prevented from acting against the polarized magnet & reducing its power but circulating within the closed circuit formed by the shunt & the wire of the Electromagnet

11) "Printing Telegraphs." (9 pages; Edison's hand).

7 Printer –

increases immensely its charging & discharging time hence very slow reversal may be sent into the circuit without any danger of actuating the lever of the Electromagnet. The shunt device is shown in fig.

This principle has been adapted in what is known as the Manhattan printer but with slight modification

This is shown in fig. C is a separate Electromagnet prevented from working by the rapid reversals. A A is the polarized magnets operating the type wheel. B the printing magnet. When rapid reversals are transmitted the levers of A A. respond & the type wheel is isolated but the Electromagnets C & B for the reason above explained as before do not respond until the current is made permanent. when they take place the lever of C.

11) "Printing Telegraphs." (9 pages; Edison's hand).

8 pounds
is drawn down and the polarized magnet is short circuited, thus diminishing the resistance of the circuit and the magnet B becomes more powerful & gives a better impression of the letter, of course the Extra magnet C may be dispensed with without in the least Effecting the result,

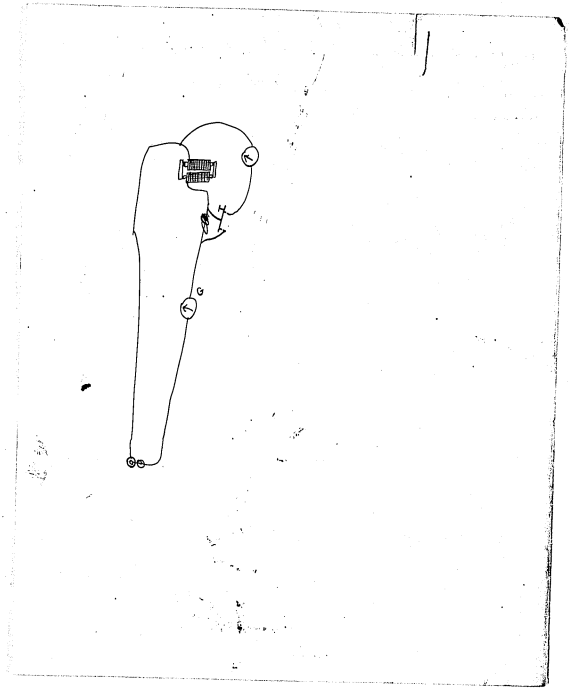
Figure — shows another plan in which the magnets are not polarized, When there is no Current in the Circuit the type wheel lever is drawn up by the spiral spring and Contact is broken at n m. throwing the printing magnet out of Circuit now when ~~rapid pulsations of a quarter length~~ pulsations are sent which are sufficient to operate the the type wheel magnet ~~and~~ its lever & no more the printing magnet will remain quiescent as but a small portion of the pulsation passes through it ~~on account~~ but if the Current be made permanent ~~the~~ sufficient

11) "Printing Telegraphs." (9 pages; Edison's hand).

will pass through 9 points to bring the
printing lever up and effect the
impression with the lever,

To find the actual get points
from General patent Ten
Box Document.

11) "Printing Telegraphs." (9 pages; Edison's hand).



11) "Printing Telegraphs." (9 pages; Edison's hand).

1 Breakwheel.

Breakwheels are wheels by the rotation of which the circuit is alternately made and broken.

The form of breakwheel ~~most~~ generally used in telegraphic apparatus is that shewn in Fig.

The breakwheel A is cut as in fig, and the spaces between the teeth filled with vulcanite, or Ivory. B is the contact arm, held against the periphery of the wheel by the adjustable spiral spring C. The teeth of the wheel are generally faced with thin platina foil to lessen oxidation.

The point of the contact arm is also faced with platina.

There are many objections to this form of break, especially when used with an electromagnet in a short circuit and with a battery of ~~low~~ or small internal resistance, amongst which may be mentioned,

i. The improper relation between the contact surface and the space, usually of the same length

ii. The great pressure required to ensure perfect contact.

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2. Break wheels,

III. — The destruction of the insulating substance by the scraping action of the contact lever

IV. — The imperfect connection, caused by the compression of the dirt from the insulation into the platinum when a little worn by the contact lever,

V. — The burning of the insulation at the point of breaking circuit, thereby prolonging the contact,

VI — Insufficient connection between the shaft carrying the break wheel and its bearings or pivots when the wheel is in motion

VII — The excess of spark due to the accumulation of platinum dust in the space made by the destruction of the insulating substance at the point where the circuit is broken,

As regards the first objection, it may be stated with some degree of acuracy, That to obtain the greatest number of perfect vibrations from the armature lever of an Electromagnet, the teeth on the break wheel

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should have two thirds more surface than the insulation between, (2) the circuit should be closed two thirds longer than it is opened.

The reason for this will be obvious when we consider, that upon closing a circuit in which there is an electromagnet, the secondary current from that magnet, sets up an opposing electromotive force to that of the battery, this lasts for a very short interval of time, dependent upon the length of the magnet. but is sufficient to perceptably retard the magnetization of the magnet. hence the extra length of the contact surface is to compensate for the effects of the secondary current. When the circuit is broken there is no route for secondary current of the opposite character to circulate. therefore it will not operate to prevent demagnetization

The resistance of the circuit in which the magnet is placed as well as the length of magnet and number of convolutions of wire around it, has an important effect on the relative proportions of contact

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to space, should the magnet be placed in such a position that a circuit is formed for the inductive current set up on breaking the circuit, by leakage or otherwise, then the effects are not all one way as the demagnetization is prolonged. ~~then~~ in this case the space may be nearly equal to the contact.

In short.= The longer the magnet, the greater the number of convolutions of wire around it, and the lower the external resistance, the greater must be the contact surface and the less the length of space, See ~~Ex~~ pages . . . . . .

Regarding the second objection, I have found that the pressure of the contact arm against the a 1½ inches diameter with thirty contacts or teeth wheel requisite to give 3000 perfect contacts per minute interrupting a circuit of ¼ large Bunsen Cell and an electromagnet of 3 ohms resistance is sufficient to wear off a platina wire $\frac{1}{16}$th of an inch in diameter, $\frac{1}{32}$ of an inch in two hours, when the rubbing surfaces were originally smooth, ~~and the diameter~~

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5 Break Wheel

I also found that with local circuits that to ensure perfect contact, the pressure must be increased directly as the speed is increased, If on a smooth wheel with a plain surface, a contact point presses with a given power, and the wheel is turned at a given speed, it will [illegible] a certain constant resistance, if the number of revolutions of the wheel be doubled the resistance will be doubled & so on, if the resistance of the circuit is very great this resistance forms but a small portion of the total resistance. its effect will not be noticable but ~~when~~ if the circuit is say 3 ohms and the contact resistance is 3 ohms then the ~~the~~ quantity of ~~gran~~ current circulating will be reduced one half by rotating the wheel, ~~consequently the I will mention here~~ By perfect contact I mean a contact which shall have no material resistance,

figure represents a form of break wheel in which the insulating substance is dispensed with. A. stop pin A in this form prevents the contact lever C. from entering too ~~any~~ deep

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into the spaces between the teeth.

The defect of this break consists in the wearing away of the ~~point of the~~ contact lever, to ~~such~~ a point where the lever will lie ~~cons~~ permanently against the pin A. and just touch the surfaces of the teeth,

Another & more serious fault lies in the fact that it is not always possible to keep the wheel running true, when this is the case half of the breaks will be long & half short

Another form is shewn in fig —— in which the contact pin is dispensed with, The contact lever is provided with a second point which rubs on an insulated wheel on the same shaft carrying the break wheel, and prevents the contact lever from entering the spaces N is the insulated wheel, As the wear on both points can be made nearly equal the length of contact will remain unchanged

fig —— shews another form. B is a smooth faced wheel, the surface of which is covered

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7. Break wheel

with platinum A. is a toothed wheel insulated from B; This wheel is provided with as many teeth as there are contacts to be made in one revolution, C is the contact lever, provided with an extra arm which engages in the toothed wheel, A, The movement given to the contact lever by the teeth on A. control the length of the contact,

The ~~spaces be~~ two points on the contact lever should be so proportioned that the extra arm shall not enter the spaces of the break wheel A to any great extent,

Another form is shown in figure - - -

The rubbing contact points shewn in the device previously described is here replaced by a contact wheel A.

The advantages gained by using a wheel is that with it will give a better contact, with (than the rubbing contact) the same pressure, and with less friction, (create much) hence the pressure may be greatly increased to ensure perfect contact without a corresponding increase of ~~the~~ friction, another advantage is that there is less wear of parts

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8 Break wheel

These are very important considerations with that class of apparatus which can spare but little power to rotate the break wheel. Where rollers are used, a small watch spring tipped with Chamois skin should press lightly against the periphery of the wheel to remove the oxide formed by the spark & to prevent dust as well as small particles of dust from being rolled into the surface of the wheel & causing imperfect contacts, frequently two rollers or points of contact are used as in fig The object be to ensure perfect contact even should one point fail

Sometimes two contact points are connected as in fig — to lessen the spark which is very troublesome when short circuits and low resistance batteries are used, This method is very effective for that purpose, lessening it at least two thirds, but ~~lessen~~ increasing the liability to make bad contact, This may be remedied however by increasing the pressure

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9 Break wheel

on the rollers

When two rollers are used to ensure perfect contact as in fig —— The length of contact may be regulated by simply moving one roller in advance of the other.

Another form of break wheel is shown in figure —— Instead of using a toothed wheel, pins are set at regular distances in the face of the smooth wheel A. C and B are two contact levers provided with prongs of some insulating substance on top of which are platina points. The pins E and D are to keep the two levers in position The platina points are held together by the two spiral springs m and m' when the wheel is rotated the pins ~~on the~~ passing between the two ivory tip seperate the levers and break connection at the platina points The metals parts of the contact levers are dark

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10 Break wheel,

in the Engraving while the insulating substance is white –

Another class of which are in some respects superior to those already described are those in which the toothed wheel is used merely as a mechanical means of vibrating a lever against a fixed or yielding point independent of the revolving wheel.

Fig shews the method usually adopted C is the vibrating lever p the contact point, The defects of this form are

I... The oxidization is accumulated at one point instead of being distributed over a greater number of points as is the case with most of the breaks already described,

II... Shortening of the contact as the points become worn by oxidization.

III --- The rebound of the lever is after it has touched the contact point. (see 150 &c) ~~although the interruption of current from this cause is very small~~. This rebound gives two contacts when only one is wanted. Although this

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11 Break wheel

Second break of the circuit is very slight, the inductive current of an electromagnet is very sensitive to them

The effect of the rebound may be entirely prevented by using a flexible spring as in figure ~~11~~ Although the rebound lever C rebounds when it touches the rigid point X. it does not rebound sufficiently to break contact with the spring S.

The length of Contact is regulated by the pins Y, Y, X

A method superior to this inasmuch as the Chances of an imperfect contact are lessened is shown in fig ~~—~~

B is the vibrating lever on the end of which are two platina points, one a little longer than the other C and D are two contact springs, both connected together, these springs are provided with platina points of the same length, facing the two platina points on the vibrating lever. The approach of these springs toward the lever are limited by the stop pins E and F.

When contacts are made the longest platina point is the last to break connection hence

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The spark will only appear at this point, leaving the other point free from oxidation. In practice when there is considerable spark and contacts are made rapidly. The longer platina point and its corresponding spring will miss one contact, generally in five hundred, when this is the case the spark comes on the shorter point and causes it to be oxidized, but it will be a long time before it will become sufficiently oxidized to make imperfect connection. Even after the long point is badly oxidized and the shorter one to a less amount. The chances against both missing at once is very great.
As oxidation shortens the longer point and alter the length of contact its corresponding spring must be adjusted forward

The most perfect break, in a mechanical point of view is that shown in fig — and is especially applicable to high speeds B is a gear wheel. O a pinion wheel of such a size that by one revolution of B the lever C is vibrated by

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13 Break wheel

The cam wheel A as many times as there are breaks required in one revolution, as this is a positive motion will be The contacts at all speeds ~~are very~~ Even - ~~and~~ figures —— and —— show other methods

Breaks wheels for reversed Current with two batteries =

Fig shows the first method,
A is the break wheel B and B the two contact levers, P is a polarized magnet,
F and G are batteries. The Zinc end of the battery G is connected to the lever B. and the Copper end of the battery F is connected to the ~~battery F from~~ lever C. The other ends of the two batteries are connected to Earth.
The wheel A is connected to the line. The Contact levers B and C are so adjusted that when the point of C is making contact with a Earth and giving a Copper Current to line. the

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point of the lever B is in the space; when
connection is broken by the point of C. that of
comes in Contact with a tooth and gives
a zinc Current to the line,

figure ~~14~~ shows another method
E and D are the two Contact points, held in
position by the limiting pins N and M,
The spring E is connected to the zinc end
of one battery. the spring D to the Copper
end of another battery. The lever C
vibrating between these two points places
the two batteries alternately on the
line.

Break wheels for reversals with one Battery

the first method

fig — shows another plan
A is a toothed wheel ~~with~~ the teeth
of which are platinized, C and B
are two vibrating levers, so arranged
that when the lever D is in a
space and in Contact with the
line point D. The lever C is in
Contact with a tooth of the wheel
A which is in Connection with the
Earth, and vice versa,

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15 Break wheel

fig. 18½ shows another form.
C is the Cont vibrating lever. d and e are two arms insulated from c and from each other f and f' are two Contact springs. g & g' are two Contact points n is the Battery — The operation of this break is as follows: When the ~~lower~~ point of the lever c is on a tooth of the Wheel. The points g' and f' ~~are connected~~ ~~which the two arm d is~~ and g and f are Connected and a Zinc Current flows to Line. When the point of the lever c is in a space The points d and f and e and f' are Connected and a Copper Current flows to Line

fig 19 —— Shows another plan

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16 Break wheel -

B is the vibrating lever provided with a double platinized foot, and is connected to earth. A and K are two points both connected to the line, F & G are two contact springs. Connected to the Ends of the battery. When the point on the lever B ~~is in a space on the wheel~~ is between the teeth on the wheel A. a zinc current flows to line, when the lever B is on a tooth, a copper current flows to line. This is a very effective & simple device.

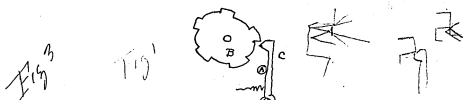
Other forms may be made by using double wheels & ~~other forms may be made by double contact point.~~ ~~heel and levers. but these already described~~

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12c) Pages 16 (2 versions), 17, and 18 of (12a) or (12b). (4 pages; Edison's hand).

Break wheels.

Figure 2 represent ~~shows~~ a form of break wheel up which where the rubber or insulating substance between the teeth are dispensed with, and a limiting pin substituted, A,



This prevents the click C ~~the click C is prevented~~ from ~~rolling~~ entering too deep between the teeth ~~any great depth in the spaces by~~ the pin A, ~~the tooth of the click the wheel will not~~

The defect of this break consists in the wearing away of the point of the click wheel ~~the pressure is decreased~~ ~~so well as~~ ~~the point wearing square~~ is liable to catch the ~~po~~ edges of the teeth on the wheel, ~~of the edge of these teeth be~~ ~~rounded then the time or length of~~ ~~Contact will be shortened as the point~~ ~~of C wears~~ another objectionable feature

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

Break wheel
2

as the pin "A" which moved in the slightest manner will increase or decrease the length of contact, in ~~Random Step~~ Step printing Telegraph work this adjustability of contact surface is especially objectionable ~~as of Commercial~~ ~~[illegible]~~ ~~[illegible]~~ as these a change in the length of contact will ~~create~~ change the adjustment of the vibrating levers,

~~Another form is shown in If a roller is used~~ Another form of break wheel is shown in fig 3

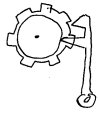


fig. 3.

Limiting ~~pin~~ shown in fig 2

in this arrangement the pin A ~~is~~ fig 2 ~~—~~ is dispensed with ~~as~~ The contact lever C is provided

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

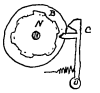
12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

3 Break Wheel.

with a second point, which rubbing on an insulated wheel prevents the click from entering too deeply in the spaces As the wear on both points can be made nearly the same the length of contact remains unaltered

Another form is shown in figure 4.

Fig. 4.



B is a smooth (lacq'd) wheel the surface of which is covered with platinum to prevent excessive oxidization

N is a toothed wheel insulated from B

This wheel is provided with as many teeth as there are contacts to be made (in one revolution) C is the contact lever provided with an extra tooth X running in the path of the wheel N. ~~These teeth~~ the movement of quick is ~~the tooth~~ click by the ~~teeth on the~~ of N control the length of break The spaces between the teeth should be shallow

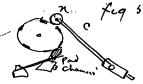
12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

and the two points 4 & 4 wheel should be so proportioned that when contact is being made the tooth X should not touch the bottom of the space

with the platinized wheel prevent the point X from dropping to the bottom of the spaces in the wheel M. any wear on the tooth points q. will be after the length of contact, about the same

Another form is shown in fig 5



(6)

The rubbing contact point shown on the previously described break wheel is replaced by a wheel n. This has great the advantage obtained by using a wheel is that it will give a better contact, and it will also and with the same pressure as the rubbing contact it will have a better contact. Because the pressure may be greater in the wheel X. Several times the pressure may be put on it without a corresponding relandalism of the

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

5 Bk wl

another advantage is less
~~Break wheel and~~ wear of Contact
Point. The point is a very important
Consideration ~~in~~ with that class of
apparatus which ~~have but~~
Can spare but little power to
rotate the break = Where a
roller is used a small ~~Shaft~~ watch spring (Type)
~~Raised break~~ should press
lightly against the periphery
of the wheel to remove the
oxide formed by the spark ~~for~~
and to prevent dust, were no
brush used the oxide ~~press~~ would be
drawn over the wheel and pressed
on the platinized surface forming
infinitessimal breaks of the
Circuit. This roller should be
made as infra

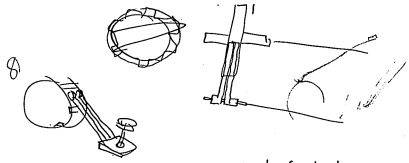
— same as pat —

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

6 Bk wheel

frequently two rollers or two point of contact are used as in fig. 12.



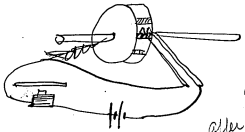
The object being to secure perfect contact of contact I tried one point fail, but extra pressure being required they

Sometimes the two contact points are connected as in figure — to lessen the spark when very heavy currents are used & short circuits with low resistance Batteries are used. This method is very effective for that purpose on account of the spark, or lessening it at least to the minimum but the liability to make of bad contact is

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

augmented ~~effect~~ This breakage may be remedied by increased pressure on the Contact points



(9)

~~Fig~~ 7 after this new leaf. Fig 7

A great advance ~~Another~~ class of breaks to those already described consists in using ~~are much superior to those already described~~ ~~consists in using~~ a bottom wheel the revolving merely as a mechanical ~~arrangement~~ device for vibrating the Contact lever before a fixed Contact point - figure shows the method usually adopted -

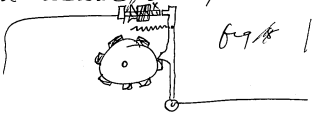


fig 11

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

8 Break Wheel

The objections to this form are first. the oxidization is accumulated at one point instead of being divided over a large number of points as is the case with the devices already described, Secondly: ~~it~~ Shortening of the ~~break~~ lever as the platina point ~~wear~~ are worn by oxidization, Third the rebound of the lever when it touches the rigid platina point, ~~The~~ Evers of having considerable mass ~~which are~~ rebound when striking a rigid point. ~~when a low motive power is used such takes a small power~~ this rebound gives double ~~breaks~~ breakers when only one breaker is wanted, (see. 182 S.C.) although this interruption is ~~infinitely~~ very small. ~~it~~ the induction current of ~~the~~ Electromagnet is very sensitive to them (see ——) hence the time of magnetization of the magnet is prolonged. ~~The~~ Effect of these rebounds may be entirely prevented by using a flexable spring ~~as in fig~~ ~~the~~ ~~method~~ as shown in ~~fig~~ 9

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

9 Breakwheel

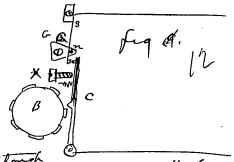


Fig 1.

12

~~By this~~ although ~~another case the~~ the rebound of C against the screw X ~~is not sufficient to allow~~ (letter place of) ~~it to break~~ contact with the ~~spring~~ platinum pointed spring S. The forward or backward motion of the spring is regulated by adjusting the plate G. The spring S press with any degree of strength against the pin n which is inserted in G -

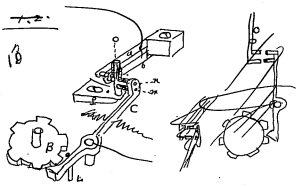
A method superior to this ~~inasmuch~~ as the ~~spark~~ chances of a ~~mis~~ bad connection is reduced. ~~one point be always preserved~~ the oxidization of one of the points (as shown in fig 16) being reduced ~~to~~ almost ~~nothing~~ entirely ~~This method is shown~~

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

10 Bk wheel

figures ~~12~~ 13



C is the vibrating lever. on the end of which are two platina points. one of the points being placed slightly in advance of the other a. b. are two contact springs both connected together having points of the same length these springs hug the pin O on the movable plate P. The upper platina point n being in advance of the lower point m. takes all the spark as it is the last point of connection the point m

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12a) "Break Wheels." (10 pages; page 13 missing; Edison's hand with Batchelor's annotations).

11 Bkwhee

leaving to spring before M
Therefore M is prevented
from the oxidization Cause by
the spark - in practice when
there is considerable spark
the points and the contact
are being made very extremely
rapid the point
M & its corresponding spring
will miss one contact in an
average of 100, when this
is the case the spark comes
on M. ~~but as this does~~
This of course cause oxidization the points
but it will be a long time
before the oxidization becomes so
great as to cause a bad contact,
M has become very dirty
long use the contact will
still be perfect as the chances
of both M & N missing at
the same time are practically infinite.
The only defect in this
arrangement is that the

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12a) "Break Wheels." (14 pages; page 13 missing; Edison's hand with Batchelor's annotations).

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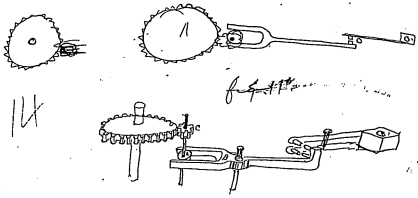
12 Bk wheel

length of contact will shorten as the point on oxidizes.

The most perfect break in a mechanical point of view is that shown in fig 11 This is specially applicable to high speeds.



14

~~As with other breaks the length will vary with~~

The Contacts are made as in fig 10. ~~Bat~~ But the toothed wheel which gives motion to the vibrating lever the length of vibration of which will vary as the rapidity of rotation of the toothed wheel increases is replaced by a gear pin & Cam wheel. A is the Cam ~~wheel~~ or Eccentric wheel working in the forked arm B.

13

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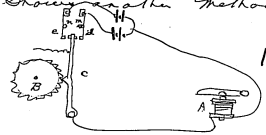
14 Bk wheel

It will be unnecessary to describe the defects of this class of breaks, as they are liable to the same defects as the Single Current Breaks,

Fig shows another method,



B is the rotated wheel to give motion to the Cover C, which has 2 projecting pieces on it, d e are the Contact spring, which may be double as in fig — resting against the stop pins n m; By the rotation of wheel B cog c makes connection with d & allows the current between L & E — against one spring & the other the L or C Battery is thrown alternately in the Circuit.

120 (3)

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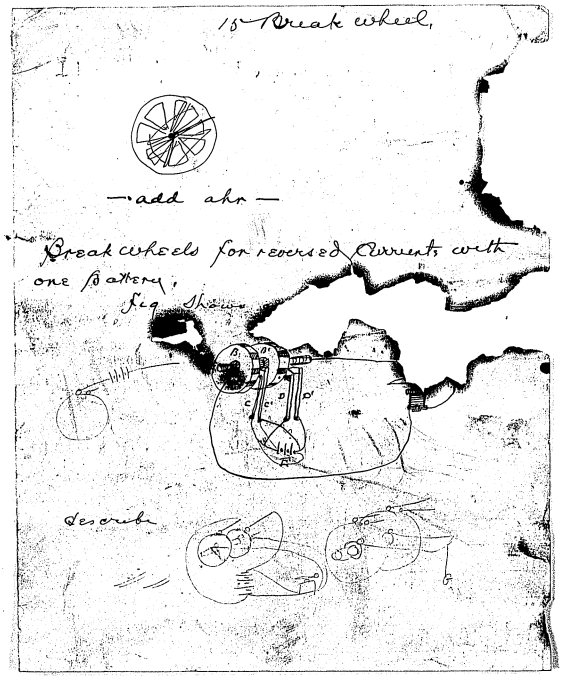
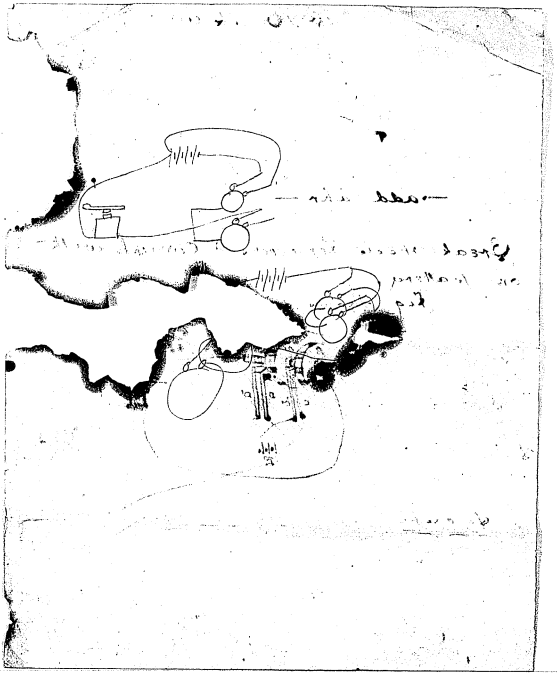


Unbound Notes and Drawings, 1874-1878

1874. Telegraph - Notes and Essays (NS-74-002)

[These pages should precede the document on reel 7, frame 240]



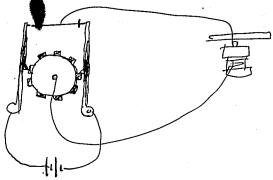
Unbound Notes and Drawings, 1874-1878

1874. Telegraph - Notes and Essays (NS-74-002)

[These pages should precede the document on reel 7, frame 240]

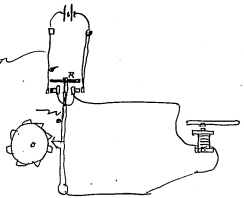
16 Bkwhel

— Shows another plan



Describe.

Another plan



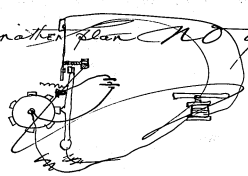
Describe.

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

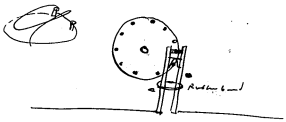
12c) Pages 16 (2 versions), 17, and 18 of (12a) or (12b). (4 pages; Edison's hand).

- 17 Break Wheel -

fig - shows another plan NO good



Add to Single Current Break



described

for removal with single point
Single Cutting see chapter

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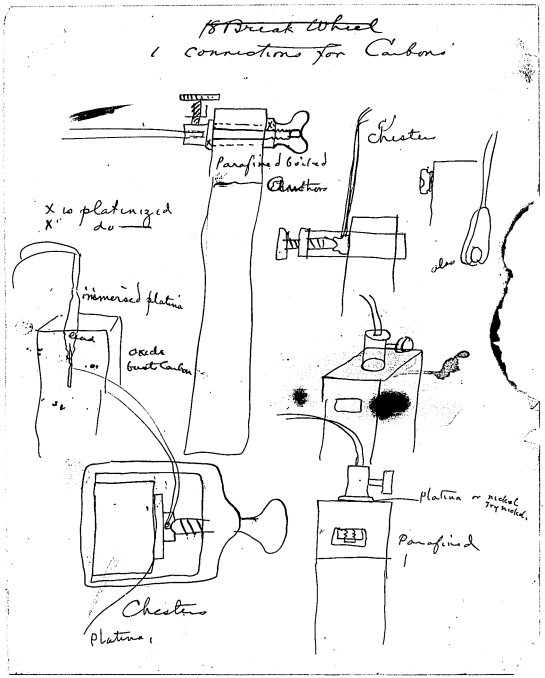

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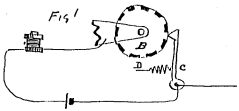
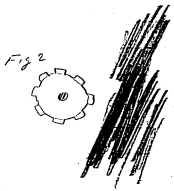
12c) Pages 16 (2 versions), 17, and 18 of (12a) or (12b). (4 pages; Edison's hand).

Break Wheels.

Figure 1 shows the form most in use in telegraphic apparatus





~~B is~~ the breakwheel B divided as in fig 2 and the spaces between the teeth inlaid with Vulcanite or Ivory. C is the contact arm held ~~with any degree of pressure~~ against the periphery of the wheel by the adjustable spiral spring D. The teeth of the break wheel are generally faced with thin platinum foil. The point of the contact arm is also faced with platinum by union with connection

There are many objections to this form of break ~~among~~ especially when used in connection with an Electro-magnet, or a circuit and with a battery of low resistance, among these

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12b) "Break Wheels." Another version in Edison's hand. (5 pages with Batchelor's annotations).

~~objectionable features~~ may be mentioned
1. To obtain the improper relation between ~~of~~ the contact surface ~~to~~ space,

2. The great tension or pressure ~~which must be placed on the Contact point~~ to ~~take~~ insure ~~proper~~ proper contact

3rd The destruction of the ~~rubber~~ vulcanite or ivory by the scraping action of the contact lever

4. ~~The insulation of the distinguished teeth~~ the insulated connection caused by the compression of the dirt from the ivory into the platinum wound part when a tooth was ~~pressed~~ formed by the contact lever.

4 The burning of the insulation at the point ~~where the contact point touches the tooth~~ of platinum connection & thereby prolonging contacts.

5 The ~~improper~~ insufficient connection between the point of breakwheel & its beam & the shaft of the break wheel, when in motion,

6th The excess of spark due to the accumulation of platinum dust in the ~~pit~~ space caused by the burning away of metal ~~formed after the tooth~~,

. Regarding the first objection it may be stated. that to obtain the greatest number of full perfect vibrations from an ~~magnet~~ armature lever. The contact surface of the ~~tooth~~ flat wheel

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should have twice the surface ~~as the space between~~ of the break, or space between. The reason for this is obvious when we consider that upon closing a circuit in which there is an electromagnet ~~that~~ the ~~discharge~~ secondary current ~~of that~~ magnet sets up an opposing EMF to that of the battery ~~at the magnet being in a closed circuit~~ which ~~this~~ prevents the magnet from being discharged immediately, hence the extra area of the contact surface is to compensate for the action of this secondary current. When the ~~contact~~ circuit is broken there is no route or circuit for the extra induced current to set up an EMF to prolong the time of demagnetization. If a very long magnet is to be used the length of contact should be still greater. ~~But of the resistance of the circuit is increase~~ The resistance of the circuit upon which the magnet is placed as well as ~~the~~ the length and number of convolutions of the magnet, has an important

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effect on the relative proportions ~~between the~~ of Contact Surface to space, as well as the action of any ~~considerable~~ leakage ~~and~~ between the battery ~~and~~ break & the electromagnet; ~~to sum up~~ in short the longer the magnet & the lower the external resistance, the greater must be the contact surface compared with the cross. the space. (see chap on discharge in closed simple ckt)

Regarding the second objection it may be stated that the pressure of the contact point requisite to give 3000 perfect contacts per minute with a small ~~no~~ number of elements within a circuit of low resistance is sufficient to wear off ~~1/50 of an inch~~ a platinum wire ~~1/10th~~ of an inch in diameter $\frac{1}{32}$ in 2 hours. On any rubbing surfaces ~~will the wear~~ interruption circuit of low resistance & small capacity ~~to~~ insure perfect contacts the pressure must be increased directly with the speed, ~~(i.e. with 1 cell of battery on electromagnet one 1 ohm resistance~~

If on a perfectly smooth wheel with a ~~cylindrical~~ plane surface ~~with~~ a contact point pressed ~~against~~

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the ~~best~~ wheel be
it with a given power and turned at a
given speed. It will offer a certain
constant resistance, all others
~~Conductors being the same over~~
If the speed of the wheel be doubled
the resistance will be doubled
~~and so on~~ constantly increasing with
the speed, ~~so constant in them~~
~~resistance~~ (~~with the increase~~ thus by merely varying the speed
~~the resistance of the breakwheel~~ ~~from one ohm to many thousand~~
~~can be increased or diminished~~ ~~either by varying the speed~~)
~~when the speed of the wheel is~~
~~even that it has been suggested~~
~~as a measure of resistance,~~

See about increasing Element,
& also the Resistance
Measure it in Bridge or
— Bradley —

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12b) "Break Wheels." Another version in Edison's hand. (5 pages with Batchelor's annotations).

(1574)
(Keyport)

number of perfect vibrations from an armature lever, ~~the contact surface of~~ the breakwheel tooth should have twice the surface of the heart or space between.

The reason for this is obvious when we consider that upon closing a circuit in which there is an electromagnet, the secondary current from that magnet sets up an opposing electromotive force to that of the battery, which prevents the magnet from being charged immediately, hence the extra amount of contact surface is to compensate for this secondary current.

When the contact is broken there is no circuit for the extra induced current to set up an electromotive force to prolong the time of demagnetization. If a very long magnet is used the length of contact should be still greater.

The resistance of the circuit in which the magnet is placed as well as the length & number of convolutions of the magnet, has an important effect on the

12) (12a) - (12e) appear to be related. These drafts all concern breakwheels and are by Edison and Charles Batchelor, with Batchelor's annotations on the Edison drafts.

12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

insulated wheel prevent the click from entering too deep into the space. As the wear on both contacts can be made nearly the same the length of contact remains unaltered

Fig 4 shews another form.
B is a smooth faced wheel the surface of which is covered with platinum to prevent excessive oxidization. A is a ~~toothed~~ wheel insulated from B; this wheel is provided with as many ~~contacts~~ teeth as there are contacts to be made in one revolution. C is the contact lever provided with an extra arm to be moved by breakwheel A. The movement given to the contact lever by the teeth of A control the length of contact. The spaces between the teeth should be shallow & the 2 points should be so proportioned that when contact is being made the extra arm should not touch the bottom of space

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

7

Another form of breakwheel is shewn in fig 5: The rubbing contact points shewn on the breakwheels previously described is here replaced by a wheel A The advantage obtained by using a wheel is that it will give a better contact & with the same pressure will have less friction, hence the pressure may be greatly increased in order to insure perfect contact. another advantage is less wear of contact point. These are very important con-
-siderations with that class of apparatus which can spare but little power to rotate the breakwheel. The roller should be made as in fig 6. Where roller are used a small watch spring tipped with chamois skin should press lightly against the periphery of the wheel to remove the oxide formed by the spark & to prevent dust & the oxide from being rolled into the surface of the wheel & making imperfect connection.

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

Frequently 2 rollers or points of contact are used as in Fig 7 the object being to insure perfect contact should one point fail.

Sometimes two contact points are connected as in fig 8 to lessen the spark which is very troublesome when short circuits & low resistance batteries are used. This method is very effective for that purpose lessening at least two thirds but increasing the liability to make bad contact this however must be remedied by increased pressure on the rollers.

Where two rollers are used to insure perfect contact, the length of contact may be increased by simply moving one roller ahead of the other

Another form of breakwheel is shown in fig 9. Instead of using a tooth wheel pins are set at regular distances in the face of a smooth wheel A. CB are contact levers prevented from touching each other by the stop pins ED. Each pin on face of wheel A makes connection between CB thereby

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closing the circuit.

A mixed superior class of breaks to those already described consists in using a wheel merely as a mechanical device for lifting a contact lever from a fixed contact point. Fig 10 shows the method usually adopted. The objections to this break are First. the oxide is accumulated at one point instead of being divided over a large number as is the case in the former breakwheels Second. Shortening of the contact as the platinum points are worn by oxidization Third. the rebound of the lever after it has touched the point. Lever rebound ~~when~~ after striking a rigid point, this rebound gives double contacts when only one contact is wanted (See) Although this interruption is very small the induction current of an electromagnet is very sensitive to them (See)

The effect of this rebound may be entirely prevented by using a flexible spring as in Fig 11

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

Although the rebound of the lever C against the pin x takes place it is not sufficient to allow it to break contact with the spring S. The stop pins N + X are adjustable thus the length of contact can be regulated by the adjustment of these pins.

A method superior to this, in which the chances of an imperfect connection are lessened is shewn in Fig. 12 the oxidization of one of the points being almost entirely prevented B is the vibrating lever on the end of which are two platinum points one a little longer than the other

C D are two contact springs, both connected together having points of the same length & pressing against the stop pins E F

The longer platinum point of the lever B takes all the spark as it is the last point of connection. The shorter one leaving its spring before the longer one, is freed from oxidization caused by the spark. In practice when there is considerable spark

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

& the contact are being made very rapid the longer point & its corresponding spring will make one contact in about five hundred when this is the case the spark comes of course on the shorter one This of course causes oxydization but it will be a long time before it becomes so great as to cause an imperfect contact After the longer point has become very dirty through long use, the contact will still be perfect as the chances of both points missing at the same time are very small As the length of contact shortens as the points oxidize it must be adjusted by the stop pins E F.

The most perfect break in a mechanical point of view is that shown in Fig 13. This is especially applicable to high speeds. The contacts are made as in Fig 12. but the vibrating lever is made with 2 prongs ~~forked~~ at one end between which revolves a cam which is worked by gears as shown in figure. The length of contact in this case will shorten as the speed

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

increases. As the cam or eccentric wheel working in the forked lever O to which as will readily be seen it gives a vibrating motion not depending on a spring but positive in its action.

Another forms of positive motion break are shown in Fig 14 & 15

In Fig 14 the lever is vibrated by means of a groove in the side of wheel A in which the bowl on the end of contact lever runs.

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

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Breakwheels for reversed currents with 2 batteries

A is a tooth wheel on which the levers B & C alternately make contact & ~~being~~ are so placed that when one is on a tooth the other is in the space; as will be seen by the connection of the two batteries in fig. 16 when C makes contact a negative & when B makes contact a positive current is thrown to line. These breakers are liable to same defects as single current breakers

Fig. 17 shows another method

B is a tooth wheel giving motion to the vibrating lever C which carries two platinum points on its end. DE are contact springs which rest against the pivot pins n & m By the rotation of wheel B the lever C makes connection with DE alternately throwing reverse currents to line

(12-2)

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Breakwheel for reversed currents with one Battery. Fig 18 shews a plan.

A is a tooth wheel which vibrates two contact levers C & B one of which is on a tooth when the other is in a space. Thus:- when C is on a tooth the point E is not in contact & B being in space point D will send a current to line, & when B is on a tooth & C in space contact made at E will send a reverse current.

Fig 19 shews another method:—

In this plan F & G are 2 contact springs one connected to each end of a battery & resting against the contact pieces E D. The vibrating lever B carries a crossarm C on its end which when it vibrates disconnects F & G alternately from their respective contact pieces. throwing reverse currents to line.

115 (1)

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

Another form of breakwheel for this purpose is shewn in fig 20

A + B are two toothed wheels insulated from each other & their spaces filled in with vulcanite or ivory, 1 2 3 + 4 are contact rollers, 5 + 6 are also contact rollers which have to make a permanent contact on with each wheel. The rollers #1, 2, 3, + 4, are so arranged that one on each wheel makes contact whilst one on each is on the insulated part. Thus in fig 20 the rollers making contact on their respective wheels the circuit is closed through rollers 3 6 5 + 1 & when 2 + 4 are making contact it is closed through 2 5 6 + 4

In making this breakwheel care must be taken to have the insulated part a little larger than the tooth

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

If R of Galvanometer,
Constant in R box:-

10000 | 20000
10000

Galv.
Shunt

10,000 | 10
1000

10 to 10 or 100 shunt which
subtracted from

10000
10
990

2500
100
4
96

96

10000
10000

5000

10000
5000
1250
6250

6250

3750

3750

12500.

2

3750

10000
2500
625
1875

1875

7,000

Photocopy. Original is in Scrapbook,
Cat. 297, Notebook Series.

Another break for this purpose is shown in fig 21

B is a vibrating lever having its ends insulated from its centre, & which is put in motion by a tooth wheel A. 1 2 3 & 4 are contact springs connected to battery as in Fig 21. The two points of vibrating lever are connected to sounder or line. By looking at the figure it will readily be seen that when the lever is on the tooth of a wheel the battery is connected with the sounder through springs 1 & 4 & when it is in the space, it is connected through springs 2 & 3 thus using reverse currents.

108 (1)

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12d) Draft essay on breakwheels by Batchelor. (12 pages; incomplete).

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E – 1687

In this fig the pin a is made adjustable by being placed eccentric in the end of stud

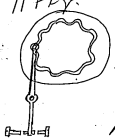
Fig 7.

Pawl shown at a after

The length of contact can be increased in this breakwheel by tightening set screws a, b & moving one a little forward.

11 Fig.

This is a positive motion breakwheel a good one where we have plenty of power, it causes considerable friction



12

Another positive motion breakwheel too much friction principal defect.

C17.

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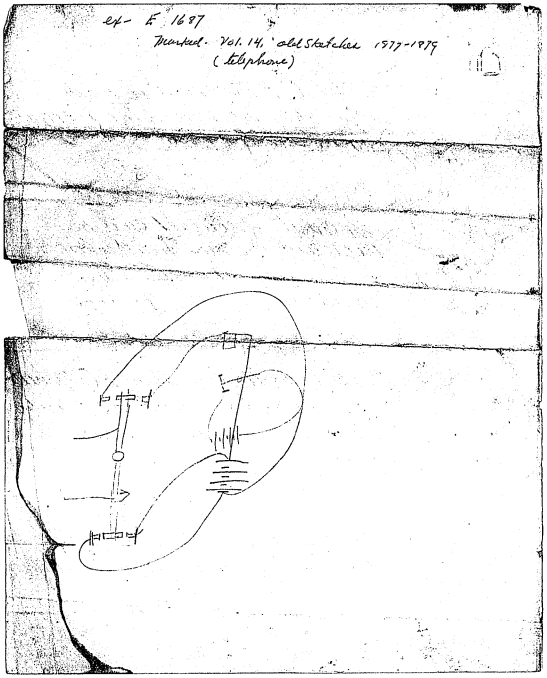
12e) Illustrations for essays on breakwheels. (9 pages; Batchelor's hand; one may be by Edison).



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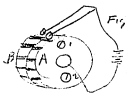
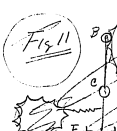
to be put in 12 way down]

By mounting the wheel as in Fig 10 on 2 supports A & B screwed together by screws 12 the length of contact can be adjusted by simply setting one a little ahead of the other.



This can also be done by setting one ahead of other.

Another form of Breakwheel is illustrated as shown in Fig 11. A wheel carries a Roller R in the T B in a Cutter ~~making~~ ~~Bearing a roller~~ on one end & make a wheel A Y on the other end contact points close or points E.P.



[27]

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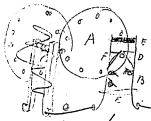
Another form of Breakwheel is shown in following fig. A is wheel on spike of which ~~in which form~~ ~~are fast to side~~ pins are set material of both in face. CB are 2 contact springs held apart by insulated pins E ~~B~~. ~~A~~ D and F are the 2 contact points which are held apart ~~held~~ ~~closed~~ ~~but each other~~ by the stop pins E. When axle rotates each pin comes in contact with the contact points ~~at~~ D and F making circuit commutator from A to G.



[3]

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12½

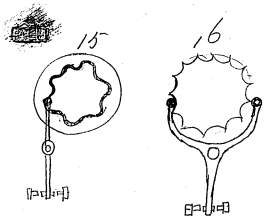

Fig 15 & 16

The advantage of this is that however quick upon the eccentric may turn it is obliged to make the contact being a positive motion independently of spring

Fig 15 & 16 shows also positive motion breaker

12)

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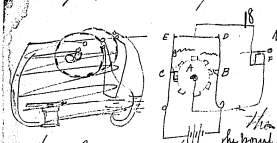
12e)

Illustrations for essays on breakwheels. (9 pages; Batchelor's hand; one may be by Edison).

15

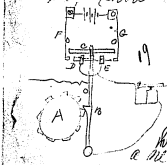
Breakwheels for reversed currents with 1 battery

Fig shows top plan



A is a boxwood wheel which ~~has~~ supports 2 contact levers ~~[illegible]~~ C & B ~~[illegible]~~ one of which is ~~[illegible]~~ on a bottom when ~~[illegible]~~ the other is in a space. When C is on a tooth F ~~[illegible]~~ the point E is not in contact ~~of~~ B but is in a space contact at D with a current flows & when B is on a tooth & C in a space contact at D ~~[illegible]~~ B only has a reverse current, directly B gets on a tooth C is in a space & contact E exists to give to line

Fig. shows mirror plan



In this plan F & G are 2 pieces connected to each end of battery, the ~~[illegible]~~ & flow. B ~~[illegible]~~ carries a cross arm ~~[illegible]~~ on the end, when lever B is behind it the current ~~[illegible]~~ F & G alternate from their respective contact pieces. ~~[illegible]~~ Contact arm is in the tooth allows forward reverse currents to flow & when lever drops into space it disconnects F & allows G to send positive to line

& contact pieces E & D

shoppin

& battery

CSJ

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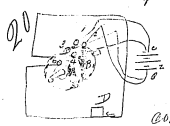
16 Breakthroughs

Another form of breakthrough & two reverse currents from a single battery



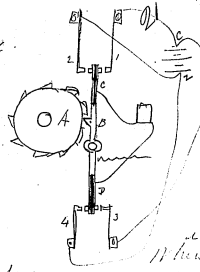
A B are two wheels insulated from each other & spaces filled in with vulcanite or ivory 1 2 3 4 are contact rollers 5 6 are also contact rollers for making a permanent connection with the wheel these rollers are so arranged that 1 4 3 are always contact at the same time & 2 4 are on the ivory & hence when 1 4 are on a conductor a current passes from carbon through & rollers 1 4 5 to sounder D & back through rollers 6 3 & zinc of battery Now if we let 2 5 4 touch contact a current passes from carbon through 2 4 6 to sounder in the opposite direction & back to zinc 5 2 –

In this breakthrough the insulator part should always be a little longer than contact

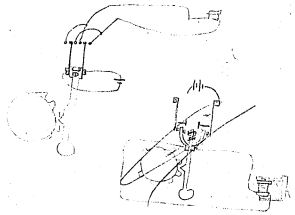
Unbound Notes and Drawings, 1874-1878

1874. Telegraph - Notes and Essays (NS-74-002)

[This page should probably precede the document on reel 7, frame 281]



Another method of reversing current on single battery is shown in A is a ~~[illegible]~~ wheel by which the lever B is moved 1 2 3 4 are contact springs, pivoted both of lever B is in space of wheel the lever comes in contact with contact springs 2 & 3 thereby a current through sounder When the lever is on top of both springs 1 & 4 are connected thereby an opposite current through sounder. The ends of lever B are insulated from each other



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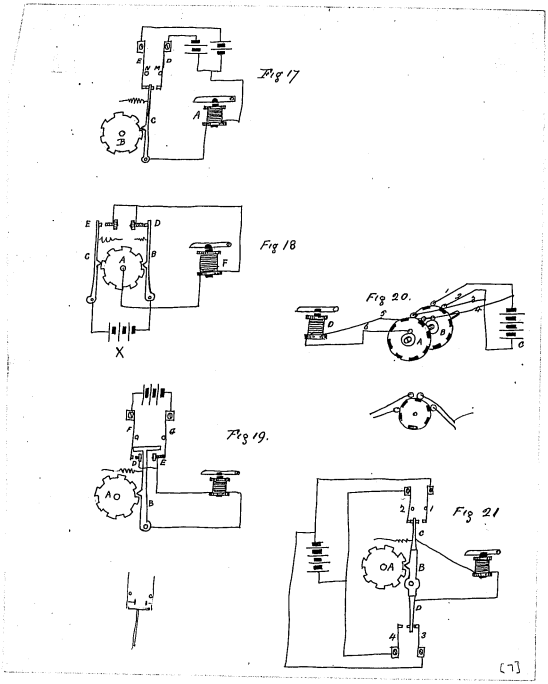

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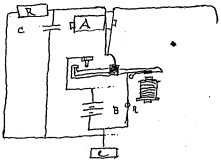

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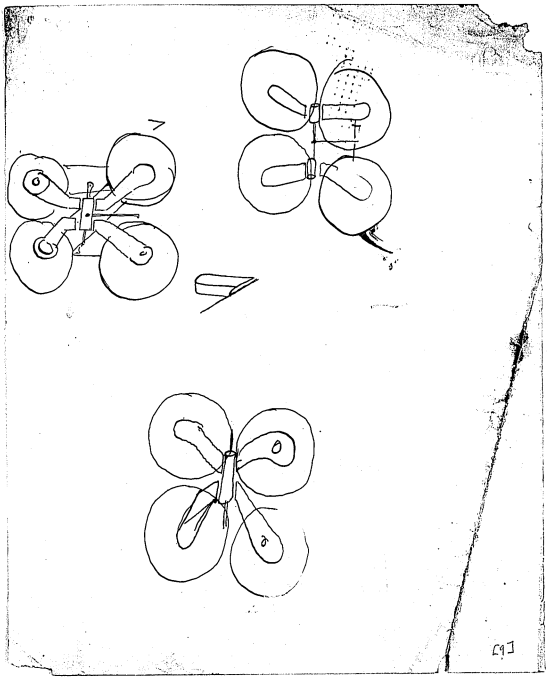

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Electro-magnets. (1873.)?

It has been said and
in this country by persons
who profess to understand the
laws of electricity and magnetism
about the proper dimensions and
resistance of ~~the magnet used~~
relays under given conditions to produce the best results.
~~There pounds Block Electrician~~
~~above this and that telegraph~~
~~functions without stint for~~
~~this~~ They ~~Critizes all the Ohm~~
Cay down Ohms law ~~as to~~ as the one to be
followed in the proportionment
of the relays in a circuit.
Ohm in fact ~~to obtain the~~
~~best results without special~~
~~apparatus~~ Ohms law the further
~~we get from~~ the means we approach
the regulation of the relays.
upon dodging Commercial
law to that law the

13) "Electromagnets." (4 pages; Edison's hand).

the result.

~~Generally speaking~~ In nearly all instances it is not a want of power in the magnet that produces bad signals, It is the self induction of the magnets themselves which mutilate them,

But the mutilation of signals which ~~follow that~~ is produced by the relays themselves by self induction in Conjunction with the Stator induction of the line ~~Cause~~ Makes the proportionment of resistance "to obtain the greatest effective power as of ~~secondary matter~~, ~~The Main~~ importance, The main point to ~~It is well known~~ be taken into Consideration in the proportionment of relays to Circuits is their self induction -

13) "Electromagnets." (4 pages; Edison's hand).

It is well known that the author employs the discharge from an Electro Magnet to compensate for the static charge of the line in his Automatic System. Owing to the liberality of his associates interested in that System he was enabled to make an immense number of Experiments on the inductive action of Electromagnets in every form and shape.

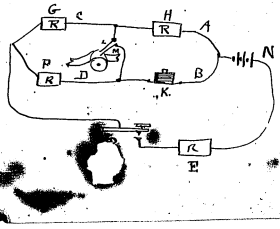
The instrument used was a Wheatstone ~~bridge~~ parallelogram in the bridge were of which was a very sensitive Chemical recording instrument ~~moved~~ the paper of which was moved by clockwork running at a regular g[illegible] speed.

13) "Electromagnets." (4 pages; Edison's hand).

4

~~The magnet which to be investigated was placed~~ ~~The~~ resulting on the chemical paper were two recording pens one of which gave a mark by a current in one direction while the other pen gave a mark from a current in the opposite direction.

The magnet or ~~device~~ apparatus that was supposed to give induction effect was placed in one of the bridge wires and its resistance balanced by resistance coils. This apparatus is shown in figure.



13) "Electromagnets." (4 pages; Edison's hand).

The laws which govern the charge and discharge of ~~th~~ the iron core of an electro magnet are nearly the same as those which govern the charge and discharge of a long insulated conductor, ~~Both are due~~ ~~to to the~~ all the phenomena in both cases are due to the ~~induce~~ production ~~of induction~~ of induction currents, which are governed by certain conditions ~~by the original~~ ~~to Dynamic Current~~.

One of the laws of electro magnets is that the charge and discharge is in proportion to the length of the iron core

The why and wherefore of this the cause etc I have been unable to glean from any investigations heretofore published that have come to my notice

~~I to~~ I was led from this want of data to undertake a series of investigations with the view of learning of possible ~~some~~ the causes of some of the phenomena ~~if not the~~ noticed by different investigators

14) "The laws which govern . . ." (2 pages; Edison's hand).

(1874)
Telegraph

and discribed in works upon the ~~subject~~ Electricity and Magnetism.

The part which the secondary or induction current performs in electro magnets operation are very complex and are undoubtedly the cause of the anamalous results obtained by some experimenters.

(My first experiment was with an ordinary magnet 1½ inches long (inch dia) wound with insulated Copper wire. the resistance being 124 ohms. This magnet was provided with a lever & armature and in fact was the same as a Relay used upon the American telegraph Lines,

This was placed in a short circuit containing 10 Cups of Bunsen battery and an adjustable rheostat; ~~its range~~ each coil of which was 30 ohms and 30 coils

14) "The laws which govern . . ." (2 pages; Edison's hand).

9 X

The operator at the distant station to balance his outgoing current upon his receiving instruments with out interference from this current from V.W.

C is the receiving apparatus and is the same as that described in the Duplex Apparatus.

F is a second limmitting magnet & lever operated by a local current Local Battery B4 & Key V

When the Key V is open the lever of F is drawn away from the magnet

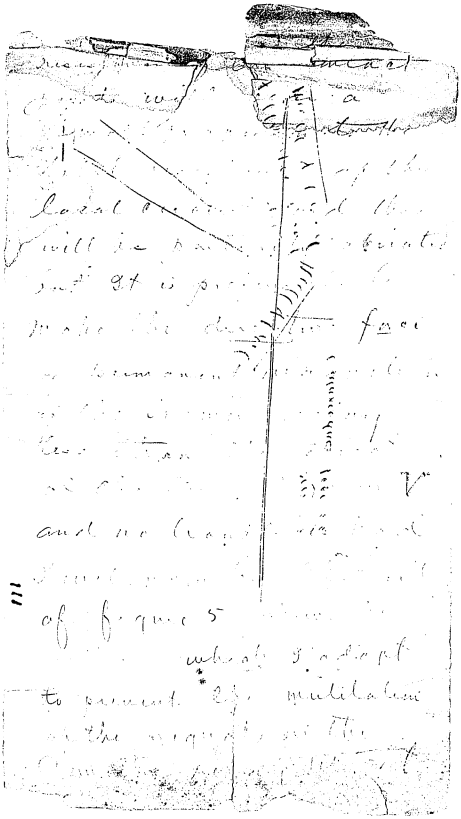
15) Incomplete essay, pages 9, 12, 14, and a damaged page. (4 pages; Edison's hand).

simple mechanical arrangement is thrown
in by the operator ~~[illegible]~~
~~with the key U~~
closing the key U the
battery W of 150 cells
is thrown in circuit and
the coil L^8 thrown out
of circuit. (the preserving
resistance equal) and
the total battery power
is augmented to 200 cells,
this passing to the
distant station is of
sufficient power to close
the relay M at that
station and if now the
key U be held closed the
whole 200 cells is
constantly received by
the operator working
the key S. These

15) Incomplete essay, pages 9, 12, 14, and a damaged page. (4 pages; Edison's hand).

14

effect on the tongue of
the polarized relay
Were the permanent magnets
of the polarized relay
three times greater than
the magnetism produced
by the current from the
battery. V. The addition
of the 150 coils would
increase the force with
which the tongue was
thrown from right to
left or left to right
and although the
signals would not
be recorded on a
moving tape when they
would be in the form of
"Sounds" operators



15) Incomplete essay, pages 9, 12, 14, and a damaged page. (4 pages; Edison's hand).

21

used two at one end of the line and two at the other end. (1875)

Two of these relays are of the ordinary character and respond to currents of a certain strength independent of the direction in which they flow, while the other two relays respond only to a change in the direction of the current and independent of its strength.

A magnet of each kind is placed so both may be washed ~~at such~~ station and both are arranged with extra magnets that the transmission of a battery a weak or strong battery current over the wire from only to Washington through the magnets at ~~each~~ one station has ~~the effect~~ no effect upon them, ~~should~~ ~~both~~ ~~extra magnets exactly~~ ~~balance~~ the effect of ~~change~~ of ~~the battery current through~~ ~~the magnets~~ ~~flow~~, but the current acts upon the ordinary relay magnet at ~~the~~ ~~station~~

16) Incomplete essay, pages 21-23. May be a continuation of (15). (3 pages; Edison's hand).

Wash

and a signal is harmonically, If now the direction of the current be reversed at NY the other magnet at Wash responds and another distinct signal is harmonically, ~~at the same time the distant electro to him can harmonical~~ ~~during~~ & intake currents and change the ~~direction of the flow~~ ~~effect~~

While these two distinct signals are being sent from NY to Wash, the latter may in this same manner harmonical two distinct signals to NY. ~~& although~~ the action of the currents on the line connected is very complicated yet no two currents pass each other in opposite directions at the same time, although this is disputed by some Electricians,

16) Incomplete essay, pages 21-23. May be a continuation of (15). (3 pages; Edison's hand).

Mr Edison, whose active brain has brought all this about, is not yet thirty years old. But for the last six or eight years his name has been well known in the telegraph world. His many inventions of both instruments & systems has done much to simplify cheapen and advance telegraphy

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16) Incomplete essay, pages 21-23. May be a continuation of (15). (3 pages; Edison's hand).

Edisons Inductorium.

~~This coil has been designed especially for family use~~, ~~The in~~ The principle of the induction coil was first discovered by the celebrated Experimental philosopher Faraday in and the first coils were constructed by Rhumakoff an ingenious French mechanician and by Prof Page an American, ~~Since~~ But little improvement in their form has been made since that time with the exception that machines of great power have been constructed, ~~In~~ the Royal

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

2

Polytechnic Institution of London has an immense induction Coil ~~some 14~~ the wire bobbin of which is about ___ feet in length and ___ feet in diameter, which gives ~~an sp~~ electric spark of 2 feet in length.

In the Stevens Institute of Technology at Hoboken is another very powerful induction Coil constructed for that institution by Ritchie of Boston Mass. which is exceedingly powerful considering

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

its size when compared to
~~the~~ the English prototype
in the Polytechnic Institution
Prof Morton has succeeded in
making the spark
penetrate through a solid
block of glass 4 inches
square ~~at~~ the course
of the spark being beautifully
shown by the fracture in the
line of the path, The induction
Coil in the hands of the hands
of the scientist has proved
a powerful instrument of
investigation, = BUT it was
not long after the introduction
of the induction Coil before
it was discovered that

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

the transmission of the
Electricity generated by it
~~had a power~~ through the
different parts of the human
body ~~had a powerful~~ Effect,
~~powerful~~
had a tendency to overcome
Certain obstinate diseases
~~which~~ when all other means
had failed, for instance
Chronic Rheumatism, ~~in the~~
~~for~~ Late years a special branch
of Medical practioners have ~~to~~
sprung up whose rely saly
upon Inductive Electricity as
a ~~main~~ remedy and many
valuable facts have be absorbed
many of which have been

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

power of the Coil is greatly lessened, ~~the effort has until now proved unsuccessful~~ ~~The lowest price coil now sold~~ and the want of a cheap powerful & economical battery which should be of a lasting character, The Effort has until now proved unsuccessful. The ~~lowest price coil having~~ lowest price which a coil of the power & workmanship can be purchased in this country is twenty five dollars and even at this price, owing to facts mentioned above little profit accrues to the makers,

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

(1879)

7

The cheapest coil sold cost twelve dollars but the the current from it is comparatively feeble,

This induction coil is wound with many turns of a four strand fine enamelled iron wire, ~~[illegible] of copper wire used in the in all previous coils, the [illegible] [illegible] point [illegible] here it is~~ in place of a single insulated wire of copper. ~~[illegible]~~ By using Iron wire, the whole coil becomes magnetic and sets up an extra inductive current which is not the case with the coil wound with copper

These [illegible]

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

The coils are then boiled for several hours in specially prepared paraffine to thoroughly insulate each convolution from its neighbor and prevent loss of power,

The workmanship of the apparatus is fully equal to that given by the best philosophical instrument makers, and unlike that of most cheap coils now sold, which are made without regard to beauty or finishing qualities, The battery accompanying this coil is a Bunsen Bichromate of potash battery complete, and the same as used by the Telegraph Co

9

with the exception that the zinc of this battery is chemically pure and will last twice as long as the ordinary zinc unnecessarily used besides giving a vibrating current and evolving no hydrogen.

It is the most powerful battery known and it may be used for other purposes than in connection with the Coil - When connected to a small electromagnet it will cause it to sustain several pounds of iron in contact with the core.

Among the uses to which the battery can be put to may be mentioned, electroplating with silver and copper etc.

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

working ~~the~~ Magnet telegraph instrument, for short lines of telegraph for ringing Electric bells, for decomposing water into Oxygen & Hydrogen gas, twenty cells will produce an intense Electric Light between ~~Lamp pound pound~~ Carbon points, 5 ~~three~~ cells will heat fine platina wire red hot) = and innumerable other uses, The power of the Coil may be greatly increased beyond human endurance by adding two to four cells instead of one, although it is seldom that a person can stand one half of the Current generated from the six cell

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

"The following are the specific diseases which it is known to cure, although it is maintained by many works on Medical Electricity that it produces good effects in many diseases not mentioned first of all & for which it is the best and only remedy is Rheumatism,

add here diseases

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

Note

By pulling the regulating rod just out of the end of the Coil a knife may be manipulated by pressing it on the top part of the rod & passing it back & forward 1/2 dozen inch -

Note

It may be made to act as a burglar alarm by attaching two pieces of tin one the window sill and Connecting the halfs of door knobs and allowing the Coil to vibrate all Night -

or by Connecting a wire so that when a window is raised or a door opened it will close Galley Cat & the handles being Connected to a Cat, she will give an unearthly & diabolical Yell & wake all up

Patent applied for

17) "Edisons Inductorium." (13 pages; Edison's hand; page 5 missing).

If a current be sent in the course of the nerves connected with the vision or taste these sensations are strongly excited — a flash light, a noise or metallic taste are at once perceived. Wilson Philp

Medical Chemistry — p 10.

The Induction Coil has lately come into general favor & is used for varied purposes as a medical cure, a means of scientific research ~~& an amusing toy for the~~ and an unfailing fount of amusement. Chem News — ~~for~~

13) "If a current be sent . . ." (1 page; Edison's hand).

Telegraphic Journal
England

To be rewritten

On the Effect of Self Induction in decreasing the speed of polarized relays

The number of vibrations which can be obtained from a polarized magnet of a given length is controlled by the Ceno Resistance of the circuit in which it is inserted, supposing there is no other interfering cause such as static induction etc. The greater the resistance of the circuit the greater will be the number of vibrations of lever per minute, supposing of course that there is sufficient EMF in the circuit to actuate the magnet. In other words if a polarized relay be inserted in a closed circuit of 200 ohms in which reversals are sent from a battery of sufficient force that the magnet of the relay will attract its tongue with a force of say 100, the number of vibrations will not be so great as when the relay is on 2000 ohms and the attraction force remaining the same, in fact if the resistance of the circuit is increased to 10000 ohms with an increase of battery power sufficient to give the magnet an attractive power of 20 only the speed number of vibrations will be several times greater than on 200 ohms resistance & a battery power 5 times greater

19) "On the Effect of Self Induction . . ." (4 pages; Edison's hand).

The reason for this is that when the relay magnet is inserted on a low resistance the electromotive force of the induction discharge is great owing to the low resistance of the circuit on which it is generated, this discharge which follows after one reversal in the same direction as that reversal must be neutralized by the next ~~revers~~ current which is in a contrary direction, this of course lessens the number of vibrations per minute, If now we increase the resistance of the circuit to 2000 ohms or 10 times greater than in the first instance, and increase the battery power so that there shall be the same EMF in the circuit as before the discharge from the relay is 10 less while the attraction power of the magnet is the same, as in this instance the flow of the discharge is checked to the extent of the extra resistance of the circuit in which it can flow or in other words the induction discharge will be 9 times less from a relay on 2000 ohms with the same EMF actuating it as upon 200 ohms If we increase the resistance to 10,000, with no leakage to forms routes or

derived circuits where the discharge from the relay can flow the discharge is so much reduced that it scarcely impedes the vibration of the tongue ~~[illegible]~~ and the limit of speed may be obtained as far as regards the inductive currents from the relay.

From these facts it is obvious ~~that were it not for the static induction of the line, it would~~ be the greatest speed would be obtained from a polarized relay when several thousand ohms were inserted between the line and the relay as the resistance or the self discharging circuit formed of the wire & the combined leakage would be so great that it would have scarcely any effect upon it, when the leakage is very great. the discharge circuit which is the earth plate on one side & the leakage on the other is of so low a resistance that the speed of vibration is enormously decreased whereas by inserting a resistance between the relay & line the speed will in the same proportion be

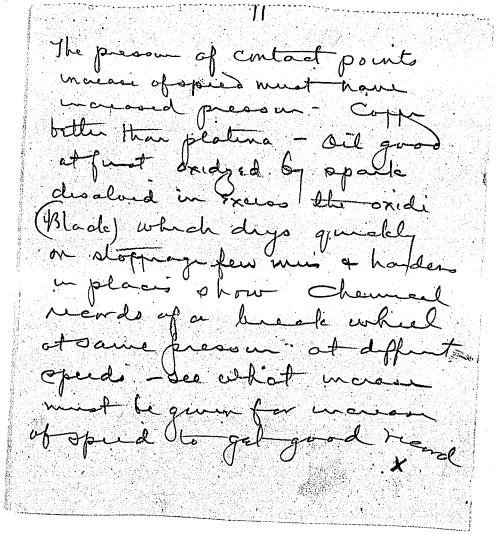
19) "On the Effect of Self Induction . . ." (4 pages; Edison's hand).

increased, [redacted]

~~[illegible] all [illegible] about relays etc~~

~~etc~~

19) "On the Effect of Self Induction . . ." (4 pages; Edison's hand).



11

The pressure of contact points increase of speed must have increased pressure - Copper better than platina - Oil good at first oxidized by sparks dissolved in excess the oxide (Blade) which dries quickly on stoppage few min & hardens in places show Chemical records of a break wheel at same pressure at different speeds - see what increase must be given for increase of speed to get good record

x

20) Three pages of fragments from essays in Edison's hand.

The ~~[illegible]~~ occupying not
more than 2 square feet of
room & the adjustment made
by a button sliding upwards
through the face

There are several other methods
of attaining this object such as
using an Extra local Coil
on the magnet through which
the equation takes place
or with a double Coil Receiver
& Earth wire the Similar to
the Duplex - In fact the
Duplex attains this object
though imperfectly the Excess
of Current due to your
own Battery not being used

20) Three pages of fragments from essays in Edison's hand.

The whole being equated for
or ~~resist~~ balance on the rela
This may account for a fact
mentioned by ~~the~~ the opera
~~that~~ Duplex gives better signals
on a very leaky wire than
when worked ~~more~~ regular
More =

20) Three pages of fragments from essays in Edison's hand.

Relay
Escape neutralized